OEC® Workstation
Service Manual

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Section 1 - Introduction

This section provides information about this manual and safety issues the reader should be aware of before servicing equipment.

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Purpose

This electronic document provides resource data and detailed instructions to help a qualified service technician isolate failures and perform repairs on the equipment. It provides sufficient detail to enable fault isolation to the modular (printed circuit board) level.

Intended Audience

Reading this manual does not qualify an untrained person to service the equipment. This publication assumes the reader is a skilled and fully qualified electronics technician who has experience servicing medical imaging systems. Factory trained service personnel will benefit the most from this material.

How to Use this Manual

The following subsections describe how to use hardcopy and on-line versions of this manual.

Hardcopy

Hardcopy versions of this manual are organized using tab dividers. Select the section of interest and then refer to the table of contents on the front page to locate the information you require.

On-Line

On-line versions of this manual are organized using a section level navigation screen. Click on the section of interest and then refer to the table of contents on the front page to locate the information you require.

Hazard Notification

The following subsections describe hazard notification conditions.

Danger

Danger Notices advise of hazardous conditions that, if ignored, WILL result in death, or severe personal injury.

Warnings

Warnings advise of hazardous conditions that, if ignored, MAY result in death, personal injury, or equipment damage.

Cautions

Cautions advise of hazards that, if ignored, MAY lead to personal injury or equipment damage.

Notes

Notes supply important information not related to hazards

Safety Summary

Do not attempt to service or maintain this equipment before reading the following safety messages.

Liquids

WARNING: *Always unplug the AC power cord from the AC outlet and use a dry or lightly dampened cloth to clean the system. Do not allow any liquids to leak into the equipment where they can cause electric shock, fires, and short circuits. If such leakage does occur, ensure that all internal circuitry is completely dry before attempting to operate the equipment.*

WARNING: *Never store or operate the system in the presence of conductive fluids like water or saline solution unless the system is adequately protected by an approved bagging or draping system. Conductive fluids can leak into unprotected areas, causing electric shock, fires, and short circuits.*

Electrical Shock

WARNING: *This equipment may contain high power electrical components and must be serviced only by personnel familiar with proper safety procedures for working around high power components.*

Dangerous voltages are present in the following areas:

Line Voltage - 120 VAC or 230 VAC

Workstation Monitors - 15,000 Volts

If the equipment must be serviced with the covers removed, observe the following precautions:

DANGER: *Disconnect both AC and battery power before discharging static electricity in electrolytic capacitors, or high voltage cables. Failure to heed this message WILL result in death or severe personal injury.*

Allow adequate time for static charges to dissipate before touching circuit components. Discharge high voltage cables and system CRTs for at least five minutes. Discharge the high energy capacitors for at least half an hour

WARNING: *Get someone to watch while you work near high voltages. That person must remain clear of all circuitry and be prepared to turn off the power to the system and render aid in an emergency.*

WARNING: *High voltage cables, electrolytic capacitors, and CRTs can retain a dangerous static charge for long periods after power is removed from the system. Some devices can acquire a charge spontaneously without direct contact with other circuitry. DO NOT touch these components unless the system is powered down and you have discharged them completely.*

WARNING: *Systems with battery packs can deliver high currents at high voltage. Electric shock from batteries can cause death or personal injury, including severe burns. Use extreme caution when working on circuits energized by or located near the batteries. Batteries are dangerous at all times and cannot be quickly discharged like CRTs and capacitors. Setting the battery pack circuit breaker to OFF removes battery current from other circuitry, but DOES NOT render the batteries harmless.*

CAUTION: *Never operate the system unless all potential equalization conductors (green wire with a yellow stripe) and related components are fastened in place. Dangerous electrical shock and improper equipment operation can otherwise result.*

CAUTION: *Remove all metal rings and watchbands before working on system circuitry. Skin burns can result when metal jewelry short circuits system electrical currents.*

CAUTION: *Do not ship system batteries with exposed terminals. Use factory-supplied shipping containers that cover the terminals with insulating material and are strong enough to contain the weight of the batteries during rough handling.*

Explosion

DANGER: *Never operate the system in the presence of flammable anesthetics or other flammable or explosive liquids, vapors, or gases. Arcs that occur during normal operation of switches and other components WILL ignite combustible liquids, vapors, or gases, causing fire and explosion.*

If flammable or explosive substances are detected:

1. DO NOT plug the system in.
2. DO NOT turn the system on.
3. If the system is already plugged in, DO NOT unplug it.
4. If the system is already turned on, DO NOT turn it off.
5. DO NOT operate light switches or other electrical equipment.
6. Evacuate all personnel immediately.
7. Notify the hospital administration and/or fire department.
8. Ventilate the room to clear the air of all flammable vapor or gas.
9. Identify and remove the source of the flammable liquid, vapor, or gas.

X-Radiation

CAUTION: *Systems with X-ray tubes produce potentially dangerous ionizing X-radiation when energized. Never operate the system carelessly or without X-ray shielding in place. Use lead aprons, eye protection, thyroid protection, and similar devices to protect yourself and others.*

Mechanical Motion

CAUTION: *To avoid collisions with people and equipment, pay careful attention when operating motorized equipment.*

Safety Interlock

WARNING: *Never bypass, jumper, or otherwise disable any system safety feature.*

Warning Labels

Heed any warning labels, that are attached to system components:

Note: *Even though this manual is supplied only in English, some labels may have a foreign language equivalent that will appear on your system.*

Symbols

Be familiar with the following symbols that appear on equipment and schematics so you can safely maintain and operate the system:

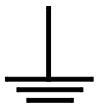
Dangerous Voltage

This symbol identifies areas where high voltages above 1500 VAC or 1500 VDC may be present. Use appropriate safety precautions.

Protective Earth Ground

This symbol identifies the system's protective earth ground terminal, which is the grounding prong on the AC power plug. This connection must be in place at all times for safe system operation.

Earth Ground Connection



This symbol identifies an earth ground connection that is necessary to maintain circuit functionality.

X-Ray Source

This X-Ray Source symbol appears on system controls you use to produce ionizing X-radiation, and on system indicators that activate when the system generates X-rays. Use appropriate precautions and use protective equipment when using system controls, and at all times when X-rays are present.

Potential Equalization Terminal

This symbol identifies system terminals which, when connected together, are at the same potential (not necessarily earth ground). Green/yellow wires normally connect potential equalization terminals together.

Anesthetic Proof Equipment

This symbol identifies equipment that is anesthetic proof in accordance with the requirements of IEC 60601-1. Never use non anesthetic-proof equipment in the presence of flammable vapors, liquids, or similar substances. Caution must be taken to prevent flammable anesthesia from coming in contact with circuit components that are not rated for anesthetic.

Attention

Attention, see accompanying documentation.

Unauthorized Modifications

WARNING: *Never perform unauthorized modifications to equipment. Doing so could result in death, personal injury, and equipment damage.*

Note: *All GE OEC Medical imaging systems comply with International Electrotechnical Commission safety standard IEC 60601-1. Do not connect any external device to the system that does not meet the requirements of IEC 60601-1 or other IEC or ISO safety standards. Only devices provided by or approved by GE OEC Medical Systems should be connected to the system.*

When properly assembled with a compatible beam limiting device, GE OEC medical imaging systems comply with the **Federal Performance Standards for Diagnostic X-Ray Systems** (21 CFR 1020.30-32), provided no components or parts are removed from the equipment and no unauthorized adjustments are present in the beam limiting device or tube housing assembly.

Never operate the system with any part of the housing or beam-limiting device removed.

Never adjust any part of the beam-limiting device unless you are directed to do so by the manufacturer.

Install all mechanical hardware (i.e., screws, nuts, bolts, etc.) that you removed during equipment maintenance or repair.

Install all EMI-RFI shielding components you removed during equipment maintenance or repair. Replace any damaged shielding gasket to ensure that the system continues to comply with EMI-RFI regulations.

Certified Components

The operating condition of certain components is critical to safety and proper equipment function. When you work on or replace any of these components, you must certify in writing that you have correctly installed, repaired, or replaced the component in accordance with the manufacturer's specifications. Complete FDA Form 2579, and file it with the FDA and any local U.S. regulatory agency. For original installations, submit the Assembler copy of FDA Form 2579 to GE OEC Medical Systems, Inc. For service calls, retain the Assembler copy with your service records. The following are certified system components.

Beam limiting device

Image intensifier assembly

Spot film device (cassette holder - optional)

X-Ray control/generator assembly

Table top - radiographic

Service Philosophy

The Medical Imaging Systems use precision components and manufacturing techniques that meet stringent regulatory requirements. Component-level repairs that maintain compliance with these requirements are sometimes not possible in the field. The system is therefore designed to be field serviceable at the modular (printed circuit board) level. This service manual makes every effort to provide comprehensive service information that is designed to help expedite fault isolation to the field replaceable assembly level and decrease product down-time.

Section 2 - Overview

This section provides an introductory technical description of the OEC Workstation. It is organized as follows:

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References

Refer to Workstation Interconnect Diagram 00-878981 as you read this section.

Major Functions

The OEC Workstation provides most of the user interfaces and all of the external data interfaces in an OEC mobile digital imaging system. It also performs the system's computing and image manipulation functions such as post processing and storage. The Workstation also provides AC power conversion, distribution, and monitoring, directs many automated functions, and reports system conditions to the operator to ensure safe and accurate system operation.

Physically, the Workstation consists of two high-resolution video monitors mounted on a moveable cart equipped with a keyboard and other user interfaces. The AC line cord that powers the Workstation and image generator enters the rear of the Workstation, as does the system interconnect cable that carries power to, receives video from, and exchanges data with the X-Ray generator. The Workstation contains many electronic assemblies, and can be equipped with optional devices such as a VCR or dye diffusion printer.

When the Workstation connects to an X-Ray generator, it can capture and process live fluoroscopic images. It can also be used as a standalone device for viewing and postprocessing stored images.

A typical Workstation appears on the following page.

WorkStation Components

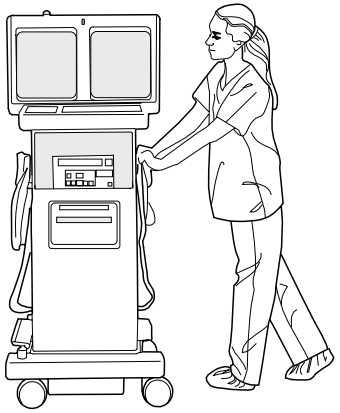
Major Components

Major internal Workstation components include the Host Controller, Display Subsystem, Cine Disk Subsystem, Image Subsystem, User Interface, External Interface, and Power Distribution Subsystem.

The following paragraphs first describe the mechanical characteristics of the Workstation, and then discuss each of the major components.

Mechanical Details

The basic Workstation without any optional equipment weighs about 400 pounds (182 kg) and stands about 64 inches (163 cm) high. Its wheelbase is about 27.5 by 27.5 inches (70 by 70 cm). One person can safely move the Workstation over level flooring or carpet.

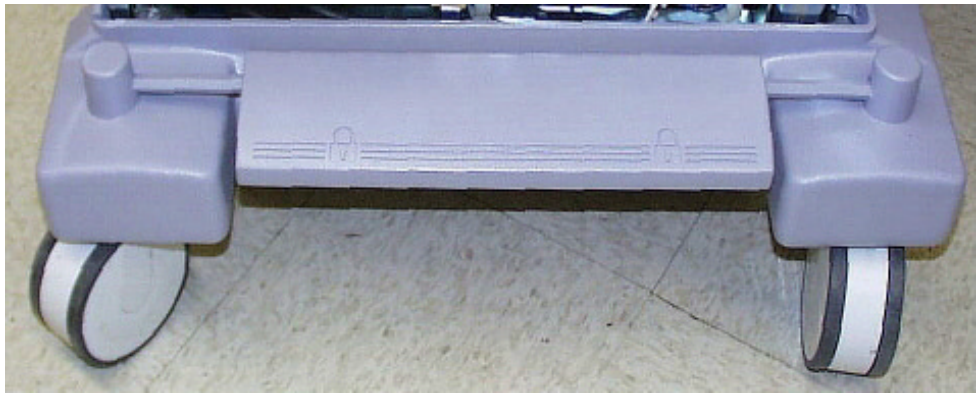


Workstation is Safe and Easy to Move

Locking the Workstation Casters

The Workstation brake pedal has three positions:

1. The **UP** position locks two of the four Workstation casters facing straight ahead, making it easier to push the Workstation longer distances, such as down a hallway.
2. The **CENTER** pedal position permits all casters to pivot freely so you can maneuver the Workstation around corners and obstacles. Use this pedal position when placing the Workstation in its final operating location.



Brake Pedal

Workstation Moving Precautions

WARNING: *Never move the Workstation up or down an incline of greater than 10 degrees. It may roll out of control.*

WARNING: *Get another person to help you when moving the Workstation up or down an incline. It may roll out of control.*

WARNING: *Never attempt to move the Workstation up or down steps. Personal injury or equipment damage may otherwise result.*

WARNING: *Never lock the Workstation in place on an incline. It may tip over.*

CAUTION: *Move the Workstation separately from other imaging system equipment.*

CAUTION: *Be careful of people and obstructions when moving the Workstation. Even low-speed collisions can result in significant personal injury and equipment damage.*

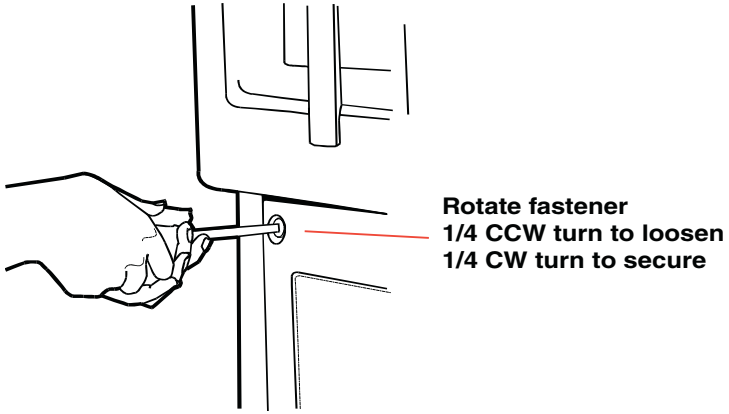
Cover Removal

WARNING: *Removing any Workstation cover exposes dangerous electrical voltages on several components. When possible, disconnect Workstation from AC line before removing any covers. When it is necessary to leave the power applied, use extreme care to avoid death or injury from electrical shock.*

Note: *Set the brake before attempting to remove Workstation covers.*

The Workstation's rear, side, and front covers are removable, as is the monitor cover. However, you must first remove the rear cover before you can remove the side or front covers. You can remove the monitor cover at any time.

Eight quarter-turn fasteners hold the rear cover in place. You must loosen all eight fasteners before you can remove the rear cover.

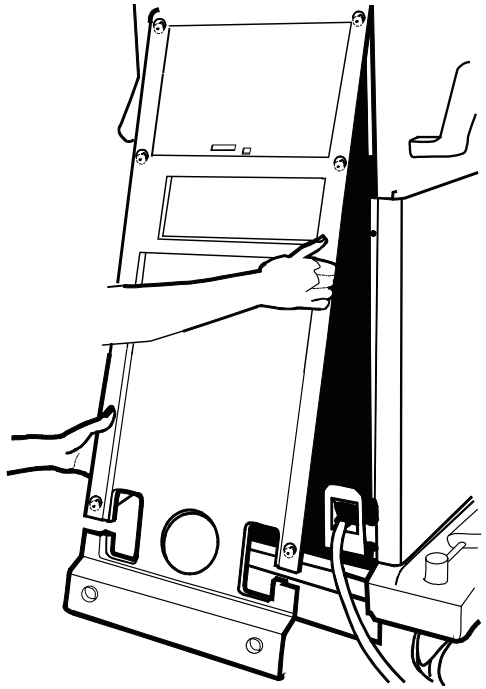


Quarter-Turn Fasteners

Rear Cover Removal

Follow these steps to remove the rear cover:

1. Loosen eight quarter-turn fasteners that secure rear cover to Workstation chassis.
2. Move the bottom of rear cover outward a few inches, and then pull cover downward and outward.



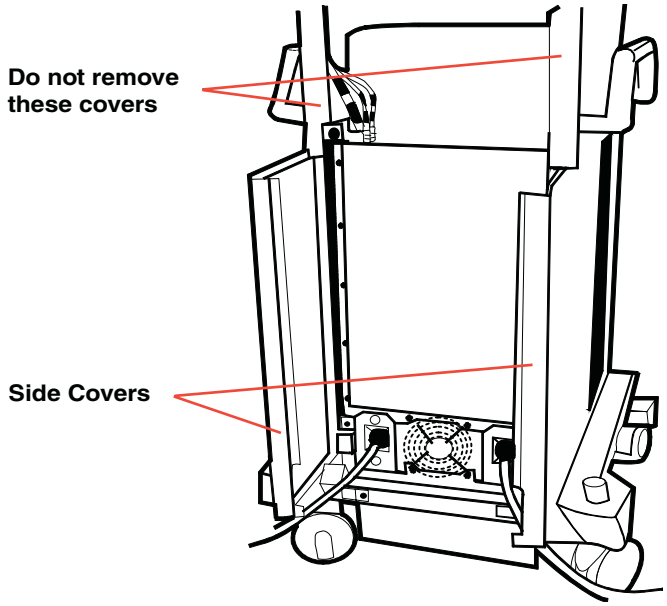
Rear Cover Removal

Side Cover Removal

***Note**: Rear cover must be removed before side covers or front cover can be removed*

***Note**: Left and right side covers fit into slots in Workstation base and under handles on either side of Workstation.*

Remove both side covers by pulling each of them to the rear of the Workstation.

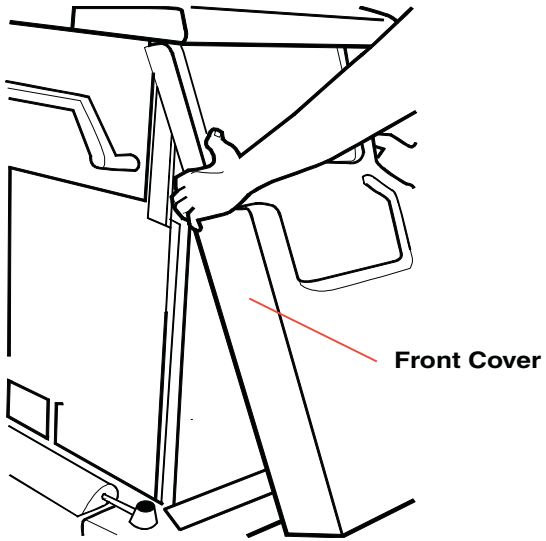


Side Cover Removal

Front Cover Removal

***Note**: Rear cover and side covers must be removed before front cover can be removed*

1. Using both hands, grasp front cover near bottom of cover.
2. Giving equal pressure with both hands, lift front cover upward to disengage two ball-nut fasteners on bottom edge of cover.
3. Move front cover upward under keyboard.
4. Move front cover outward, then downward to free it from Workstation.

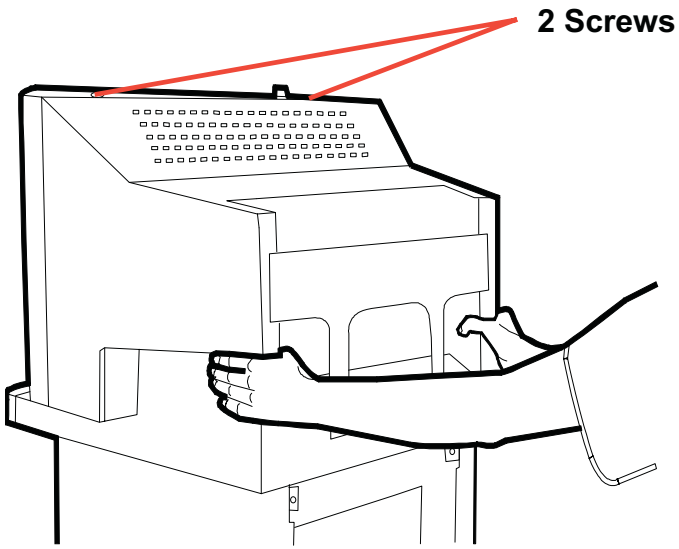


Front Cover Removal

Monitor Cover Removal

***Note**: Ball-nut fasteners hold bottom of monitor cover to front of monitor chassis.*

1. Remove two torx screws at top of cover.
2. Grasp monitor cover with both hands.
2. Pull monitor cover away from Workstation to free ball-nut fasteners from front of monitor chassis.

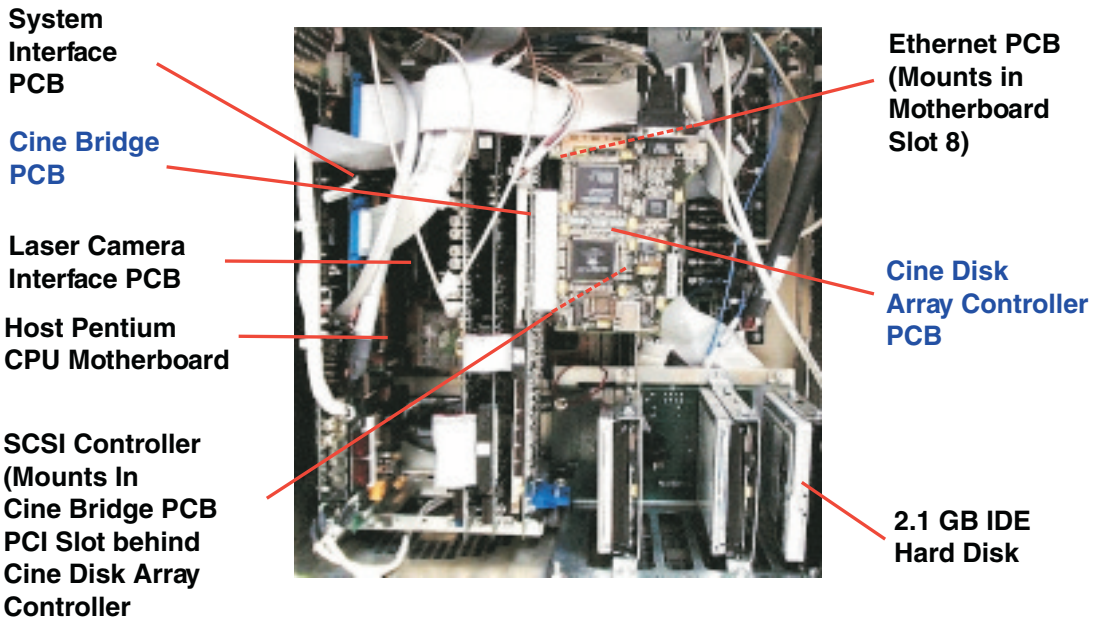


Monitor Cover Removal

Host Controller

The following is a basic description of Host Controller hardware. Refer to **Section 4 - Host Controller** for detailed circuit descriptions, troubleshooting information, and component replacement instructions.

The Host Controller manages image acquisition, image processing, image display and annotation, image storage, and user communications. Host Controller circuitry consists of a high-performance Host Pentium CPU motherboard, System Interface PCB, SCSI Controller PCB, Ethernet® (DICOM) Interface, Laser Camera Interface, IDE Hard Disk Drive, and 3.5-inch floppy disk drive. These devices reside in the Electronics box, located near the base of the Workstation.


System Interface PCB
Cine Bridge PCB
Laser Camera Interface PCB
Host Pentium CPU Motherboard
SCSI Controller (Mounts In Cine Bridge PCB PCI Slot behind Cine Disk Array Controller
Ethernet PCB (Mounts in Motherboard Slot 8)
Cine Disk Array Controller PCB
2.1 GB IDE Hard Disk

Host Controller Components in Electronics Box

Host Pentium CPU Motherboard

Nearly all Workstation functions are software controlled. The software executes in a multi-processor environment in the Host Pentium CPU, which communicates over the ARCNet bus to control the other intelligent devices in the Workstation and in the X-ray generator.

When the Workstation powers up, the Host Pentium CPU loads system or diagnostic software from a 1.44 Mb floppy disk mounted in the floppy disk drive located at the rear of the Workstation. If the floppy disk drive is empty (usually the case) the host Pentium CPU instead loads system software from the Workstation IDE hard disk drive. Following a successful boot-up with software loaded into memory, the motherboard begins various run-time chores such as initializing intelligent peripheral devices and processing user inputs.

The motherboard has four 16-bit ISA slots, three of which are used. These slots are usually populated with the System Interface PCB, optional Laser Camera Interface, and Video Controller PCB. The spare ISA bus slot is normally empty, but it can accommodate a VGA video card for diagnostic purposes.

There are four 32-bit PCI bus slots, all of which are used. These slots support the Display Controller PCB, Image Processor PCB, Cine Bridge or SCSI Controller, and Ethernet (DICOM) card.

Single Board Computer and Passive Backplane

Earlier versions of the Host Controller consisted of a standard Socket 7 motherboard equipped with conventional PCI and ISA slots that accommodated the peripherals.

The current version of the Host Controller consists of a **Passive Backplane** that supplies the PCI and ISA slots. A special slot on the Passive Backplane accommodates the **Single Board Computer** (SBC), which performs the same functions as the earlier motherboard, but is easier to troubleshoot and replace.

Please refer to **Section 4 - Host Controller** for more information.

System Interface PCB

The System Interface PCB resides in ISA bus slot 2 of the Host Pentium CPU motherboard. As its name implies, the System Interface PCB helps the Host Pentium Processor communicate with other system devices. Main features of the System Interface PCB include:

- An Option PROM that configures the Host Pentium Processor's BIOS for operation in the Workstation
- An ARCNet Controller and Interlock that enable the Host Pentium Processor to communicate with other intelligent PCBs in the Workstation and in the image generator
- Data bus buffers that develop rewind, fast forward, play, pause, and record signals for the optional video cassette recorder (VCR).
- Serial communication chips that enable the Host Pentium Processor to communicate with the modem, monitors (for setup and automatic contrast/brightness control), Control Panel PCB, and Touch Screen assembly

SCSI Controller PCB

The SCSI Controller PCB located in PCI Bus 0 slot 7 enables the Host Pentium Processor to communicate with several daisy-chained peripherals, including a removable media hard disk drive, CDROM drive, and magneto-optical drive. The principal advantage of using SCSI technology is that one interface can control up to seven devices.

When the Workstation is equipped with an optional Cine Disk subsystem, the SCSI controller PCB connects to the PCI Bus on the Cine Bridge PCB.

Ethernet (DICOM) Interface PCB

The optional 32-bit Ethernet adapter PCB resides in PCI Bus 0 slot 8. The PCB allows the Workstation to transmit images over a local DICOM network. The card can communicate at up to 132 Mb/s with the Pentium PCI motherboard, and at 100 Mb/s over the network.

VGA Video Card

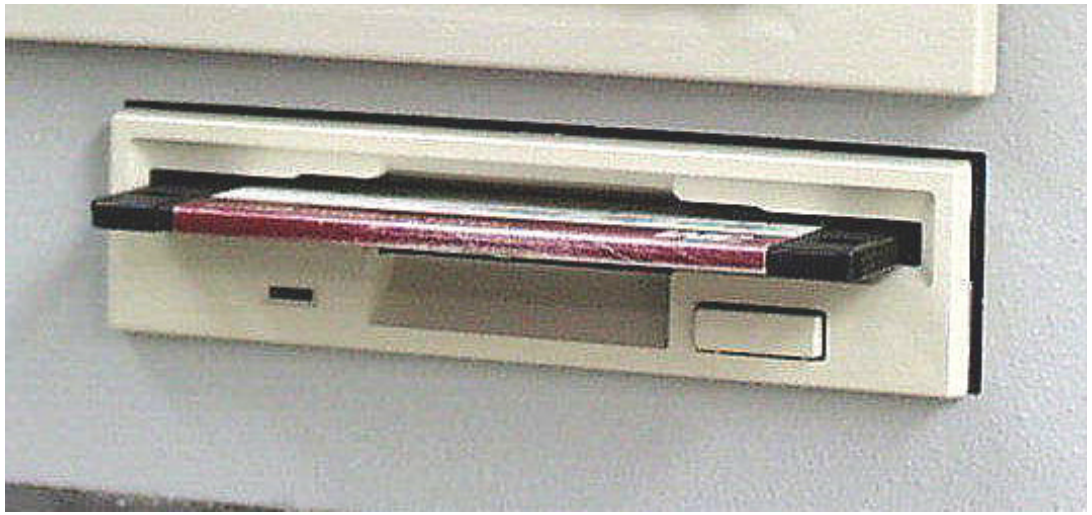
ISA Bus Slot 4 in the Host Pentium CPU motherboard is normally vacant and unused. It can, however, accommodate a VGA video card that may be used for diagnostic purposes.

IDE Hard Disk Drive

The Workstation normally boots from the 50-megabyte non-DOS partition of this 4.3-Gigabyte drive, which contains the Nucleus® operating system and OEC application software. This drive also has a DOS-readable partition that is available to the user for image and data storage. The IDE hard disk drive is located in the bottom right-hand corner of the Electronics box.

Floppy Disk Drive

The 3.5-Inch, 1.44-megabyte floppy disk drive, located on the Workstation rear panel at the rear of the Electronics box, serves as an alternate boot drive; it can also store single images on standard 3.5-inch floppy disks.



3.5-Inch, 1.44-Megabyte Floppy Disk Drive on Workstation Rear Panel

Display Subsystem

The following is a basic description of the Display Subsystem hardware. Refer to **Section 5 - High Resolution Displays** for detailed circuit descriptions, troubleshooting information, and component replacement instructions.

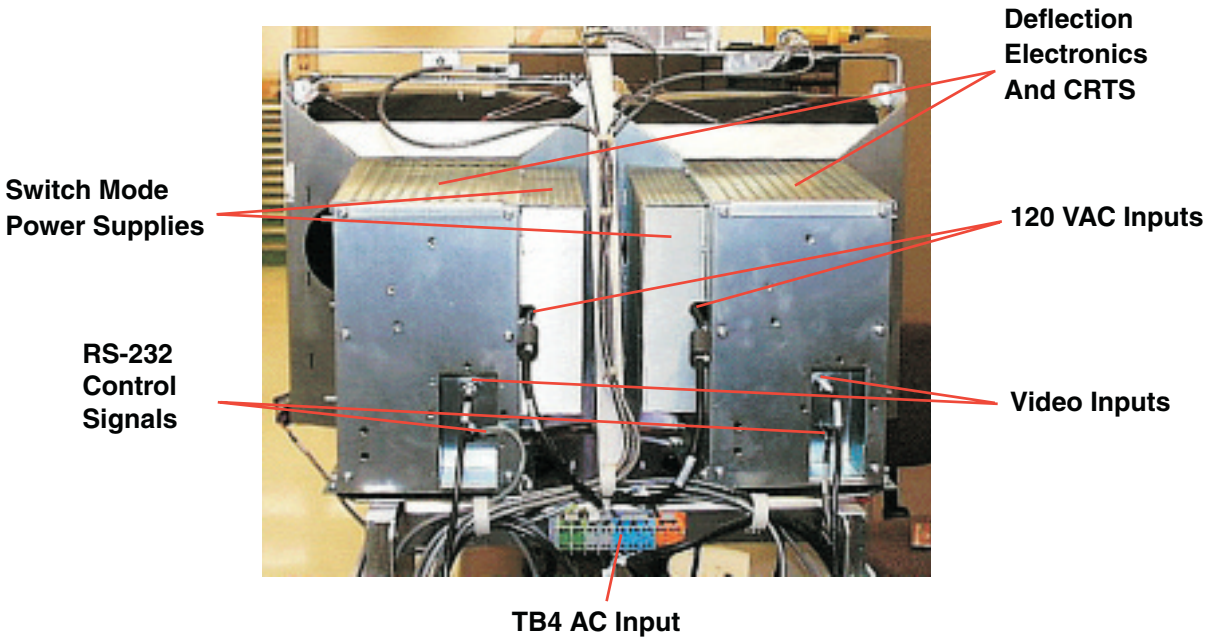
The Display Subsystem consists of two 16-inch, high resolution, high contrast, high brightness, monochrome monitors. Each monitor can display up to 1030 lines per frame with 1320 pixels per line maximum. The left-hand monitor is called the Primary display because it shows newly acquired images. The right-hand monitor is called the Secondary display; it shows acquired images and provides a mounting place for a Touch Screen assembly that you can use with a CRT-displayed graphical user interface to control many system functions.

The monitor frame serves as the mounting point for the **X-Ray On indicator**, **infrared remote sensors**, **ambient light sensor**, and the lighted **ON/OFF pushbutton**, which are described elsewhere in this section.

High Resolution Displays

The following illustration shows a rear view of the two Workstation monitors. Both monitors are electrically identical; each is powered by 120 VAC from TB4, and each receives its video drive signal from the Display Controller PCB. The System Interface PCB supplies control signals from the Host CPU to the monitors. These RS-232 signals control image contrast and brightness, and setup parameters such as vertical size and raster centering.

Mechanically, the Primary and Secondary displays are approximate mirror images of each other. The larger cage on each monitor holds the CRT, deflection electronics, and video circuits. The smaller cage holds the switch mode power supply.

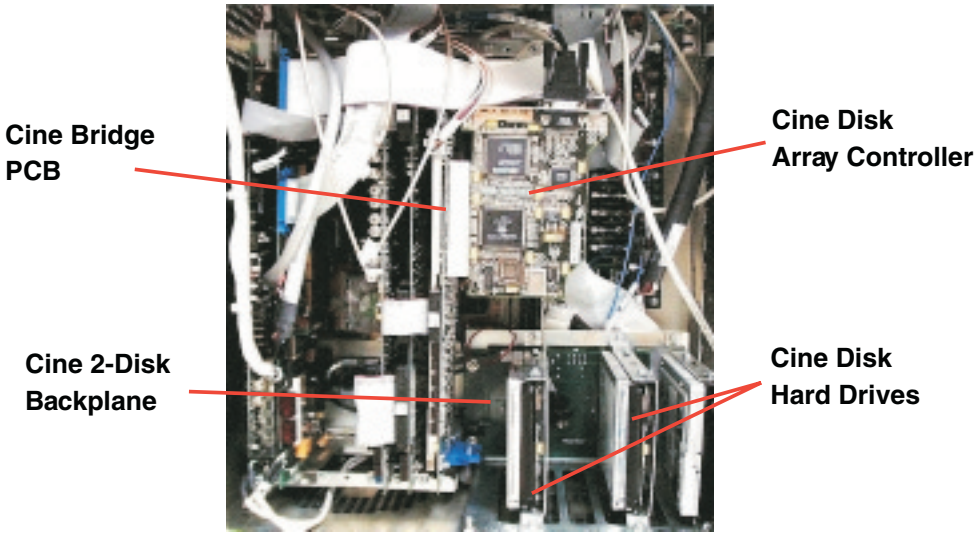


High Resolution Displays - Rear View

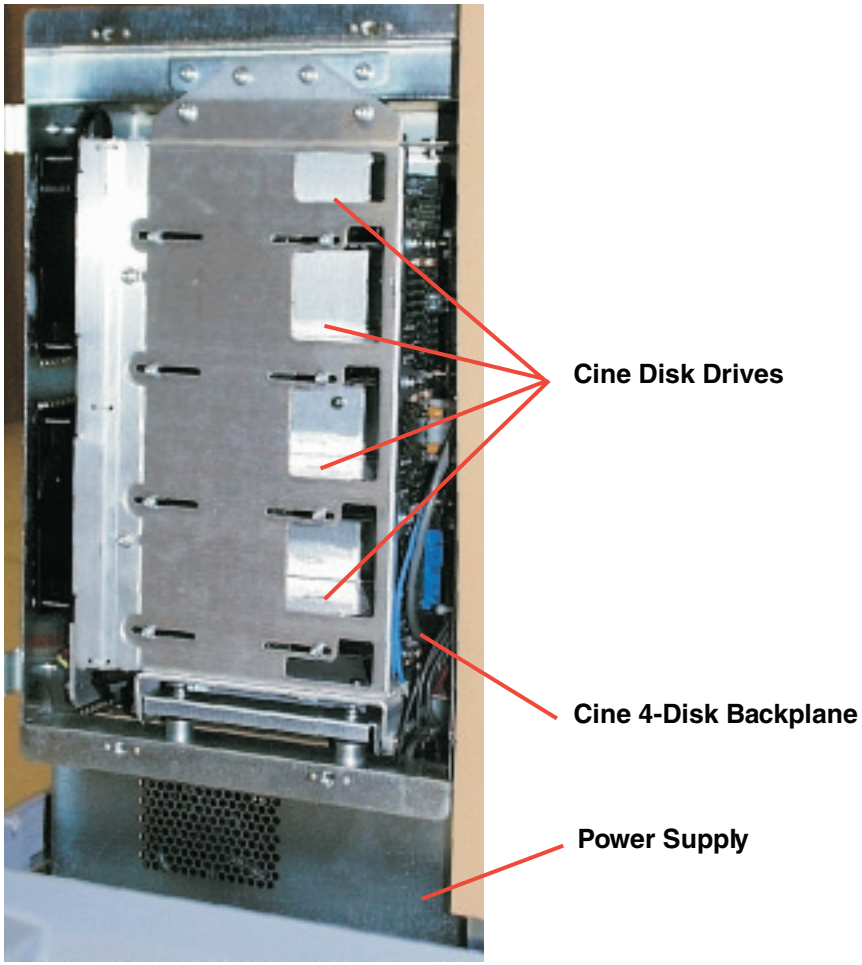
Cine Disk Subsystem

The following is a basic description of the Cine Disk hardware. Refer to **Section 6 - Cine Disk Subsystem** for detailed circuit descriptions, troubleshooting information, and component replacement instructions.

The optional Cine Disk Subsystem allows the Workstation to capture digitized X-Ray images from its Image Subsystem at 15 FPS or 30 FPS (12.5 and 25 FPS at 50 Hz). The Cine Disk Subsystem consists of the Cine Bridge PCB, which mates with a PCI bus slot on the Host Pentium CPU, a Cine Disk array controller that resides on the Cine Bridge PCB or plugs into one of the PCI 1 bus slots on the Cine Bridge PCB, one or two Cine Disk Backplane PCBs, and up to six hard disk drives. The larger four-disk backplane resides in a separate Cine Disk assembly with its own power supply near the Electronics box. The two-disk backplane and associated hard drives mount inside the Electronics box.



Cine Disk Components in Electronics Box



Cine Four-Disk Assembly (Covers Removed)

Cine Bridge PCB

The main purpose of the Cine Bridge PCB is to generate another PCI bus (PCI Bus 1) that is separate but linked to the Host Pentium CPU's PCI Bus (PCI Bus 0). Although the Host Pentium CPU maintains control of PCI Bus 1, it is actually a reserved, high-capacity data path between frame memory on the Cine Bridge PCB and the Cine Disk array. Having a separate PCI bus enables the Host Pentium CPU to maintain its full PCI bandwidth while images transfer at required speed to and from the Cine Disk drives.

The Cine Bridge PCB accepts X-Ray image data from the Image Processor as 10-bits-per-pixel parallel data. During image acquire mode, the Cine Bridge PCB packs three pixels into a single 32-bit word and stores the packed image in one of three frame buffers. During image playback, frame data from the disk drives fill one buffer while a pixel packer unpacks a different buffer. The Cine Bridge PCB returns image data to the Image Processor in the 10-bit-per-pixel parallel format.

Cine Disk Array Controller

The cine disk array controller is also known as the Fibre Channel Arbitrated Loop (FC-AL) Disk Controller. It provides the data interface between the Cine Bridge PCB and the cine disk drives. The controller's job is to exchange image data with the frame buffers on the Cine Bridge PCB and the Cine Disk drives.

The FC-AL serial data loop daisy-chains to each drive, starting at the controller and returning there after passing through the backplanes. Loop data leaves the controller on fibre channel cable and arrives at the Two-Disk Backplane, where it enters the first disk drive and then the second disk drive on the backplane. The output of the Two-Disk Backplane feeds the input of the Four-Disk Backplane, again on fibre channel cable. After passing serially through each drive on the Four-Disk Backplane, the 1.063 Gb/s loop data returns to the controller, once more on fibre channel cable.

CAUTION: *Fibre channel cable is very fragile. If the foam core supporting either conductor is kinked or pinched, an impedance "bump" occurs at that point, attenuating the high rate FC-AL signal and sometimes causing data loss. Never compress a fibre channel cable or bend it with a radius of less than 0.5 inches.*

Cine Disk Backplanes

Each Cine Disk Backplane performs several functions:

- Provides power to each disk drive
- Provides looping input and output FC-AL fibre channel connectors
- Provides loop resiliency circuits (LRCs) that detect whether drives are plugged in and route the FC-AL signal past missing or inoperative drives

Cine Hard Disk Drives

The Cine Disk drives are much like standard SCSI drives, except that they contain circuitry that unpacketizes incoming commands and data into normal SCSI format, and packetizes outgoing SCSI data for transmission over the FC-AL loop.

Image Subsystem

The following is a basic description of the Image Subsystem hardware. Refer to **Section 7 - Image Subsystem** for detailed circuit descriptions, troubleshooting information, and component replacement instructions.

The Image Subsystem processes video from the CCD camera to produce enhanced images for the Display system monitors and Cine Disk subsystem. The Image Subsystem also produces standard resolution interlaced video for the optional VCR, and digitized images for the DICOM interface, optional laser camera, and optional hardcopy devices. The Image Subsystem includes the Video Controller PCB, Image Processor PCB, and Display Adapter PCB, all of which are located in the Workstation's Electronics box.

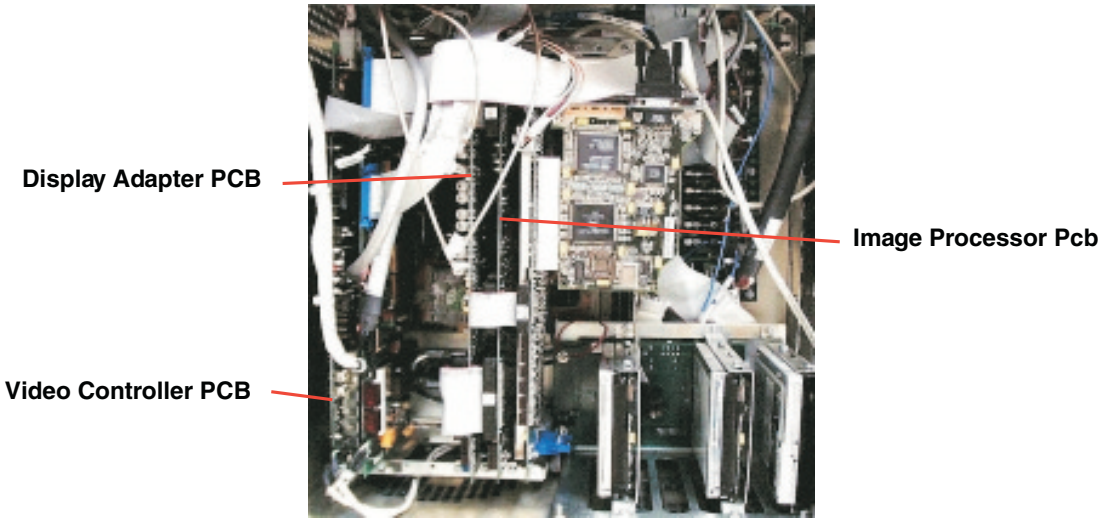


Image Subsystem Components in Electronics Box

Video Controller

The Video Controller accepts analog differential video and pilot tone (sync) signals from the CCD camera. The pilot tone signal contains sync, drive, and pixel clock data. The Video Controller converts the analog video signal to ten bits per pixel parallel data, which it sends to the Image Processor.

The Video Controller performs Genlock control for the Workstation, anti-aliasing and anti-vignetting of the digital X-Ray images, and creates the VLI window needed for the X-Ray Generator to perform Automatic Brightness Stabilization.

Image Processor

As its name implies, the Image Processor manipulates the digital video from the Video Controller to produce the following effects and functions in the displayed images:

- Vertical and horizontal image reversal
- Circular blanking
- Window and level control
- Automatic sample window positioning
- Real-time image edge enhancement
- Subtraction
- Peak opacification
- Zoom and roam
- Cine interface generation
- Text and graphics for image annotation

Display Adapter

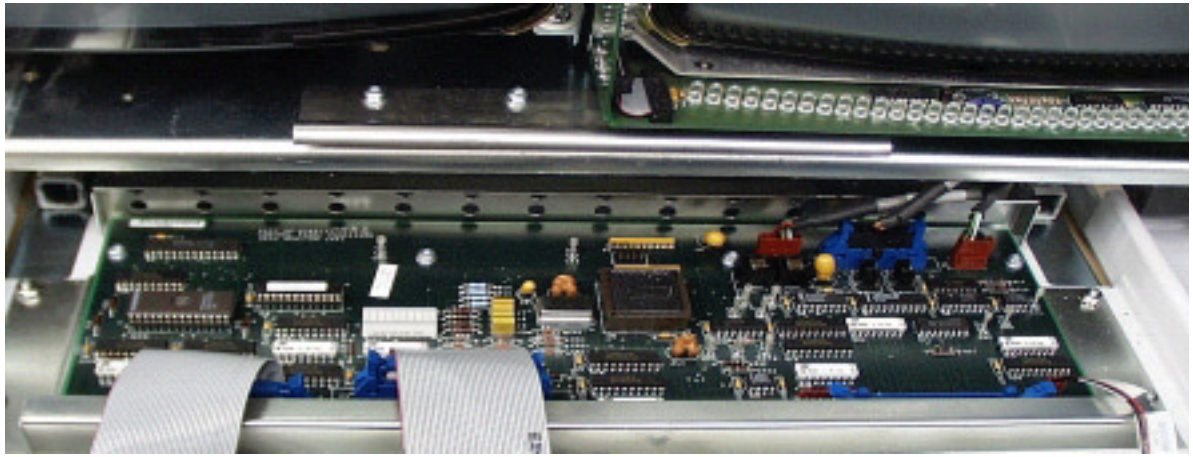
The Display Adapter PCB translates the 25 or 30 FPS 1024 x 1024 pixel images generated in the Image Processor to 60 or 75 FPS non-interlaced video for output to the high-resolution display monitors. The Display Adapter also converts the non-interlaced Image Processor video to standard resolution interlaced video that is compatible with PAL or NTSC video cassette recorders and monitors.

User Interfaces

The Workstation's user interface includes the Control Panel Processor (a PCB that mounts below the Keyboard), Keyboard, Infrared Receiver and Handheld Transmitter, Touch Screen, XRAY ON indicator, and ON/OFF pushbutton. Refer to **Section 8 - User Interface** for detailed circuit descriptions, troubleshooting information, and component replacement instructions.

Control Panel Processor

The Control Panel Processor (CPP) scans for key closures on the Keyboard and reports these closures to the System Interface PCB in the Host Controller subsystem for further processing. The CPP also responds to commands from the System Interface PCB to light Keyboard LEDs.



Control Panel Processor

Keyboard

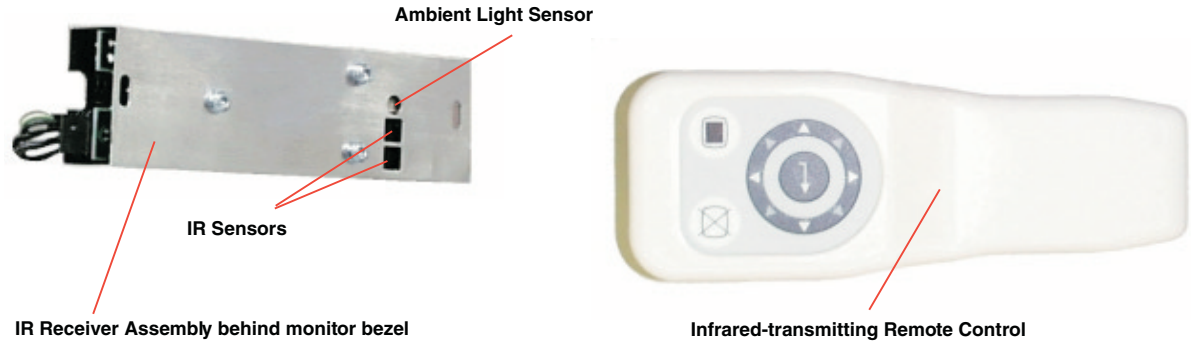
The operator uses the keyboard to enter patient annotation information and control system operation. The keyboard has a standard QWERTY alphanumeric key array, plus several special-purpose keys. It is covered by a flexible membrane designed to resist liquids and other contaminants, and is replaceable (but not repairable) in the field. The keyboard PCB has no active circuitry; its keys are scanned by the Control Panel Processor, which also drives the LEDs on the keyboard PCB.

Keyboard

Infrared Remote

The optional infrared (IR) remote system consists of a battery-operated, hand-held IR transmitter, and an IR receiver that mounts between the two Workstation monitors behind the bezel. You can use the hand-held transmitter up to 20 feet from the Workstation to access most system functions. When you press a button on the hand-held IR transmitter, the transmitter generates a pulsed waveform and converts it to invisible infrared light, much like a standard television remote control. The IR receiver assembly in the Workstation detects the IR beam from the transmitter, converts the pulsed infrared light back to an electronic signal, and passes the signal to the Control Panel Processor for decoding and processing.

The ambient light sensor is part of the high-resolution **Display Subsystem**. It senses room lighting conditions, enabling the display subsystem to maintain proper monitor brightness.

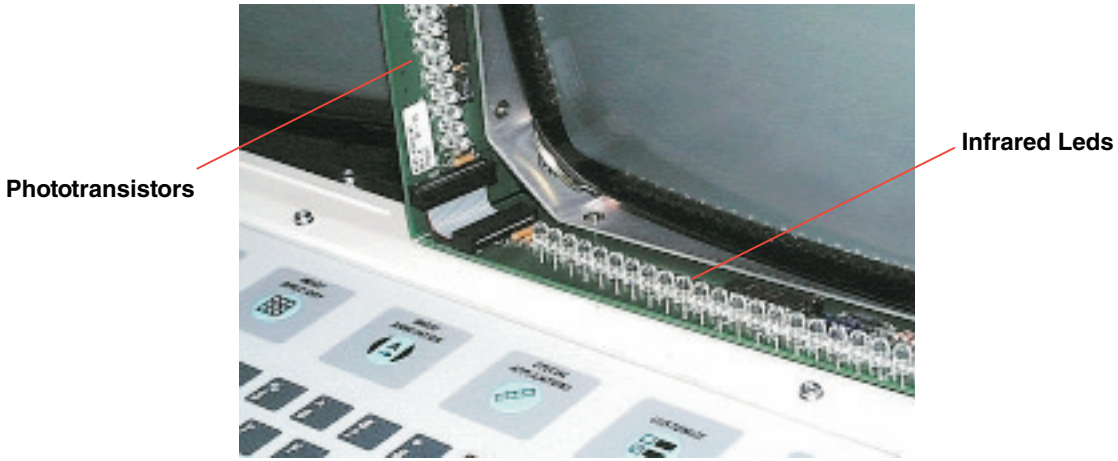


IR Receiver and Hand-held Remote Control

Touch Screen

The Secondary system display (i.e., the right-hand monitor) is equipped with an array of infrared light-emitting diodes and a corresponding array of phototransistors that detects the presence and calculates the location of a finger touched to the CRT. You use this touch screen feature in conjunction with displayed software screens to make mode and function selections during Workstation operation.

The LEDs and phototransistors are arranged in a rectangular matrix on a touch frame that surrounds the edge of the CRT. These devices are ordinarily invisible behind the monitor bezel. The touch frame has 43 LEDs on the right-hand edge, 43 LEDs on the bottom edge, 43 phototransistors on the top edge, and 43 phototransistors on the left-hand edge. A simple controller associated with the touch screen scans each phototransistor several times a second to detect beam interruptions, determines the x and y coordinates for the beam interruption, and transmits that information via RS-232 interface to the System Interface PCB for further processing.



Touch Screen Assembly

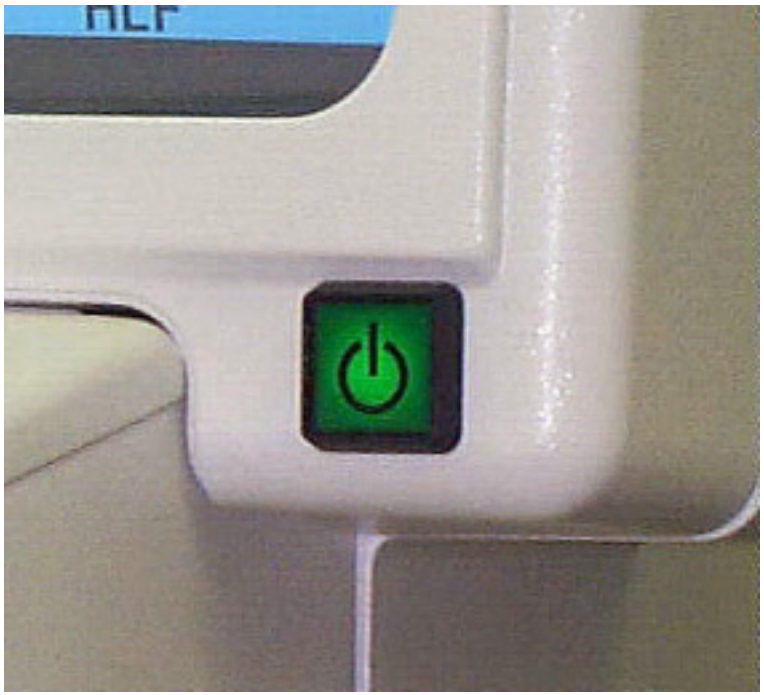
X-RAY ON Indicator

The X-RAY ON indicator lights at any time the system generates X-rays. Located on the top of the left-hand monitor, the indicator contains an array of six LEDs driven by a signal from the System Interface PCB.

X-Ray On Indicator

Lighted ON/OFF Pushbutton

The lighted SPST ON/OFF pushbutton controls application of AC power to the Workstation. The switch's 12-volt incandescent bulb lights when the Workstation is on.



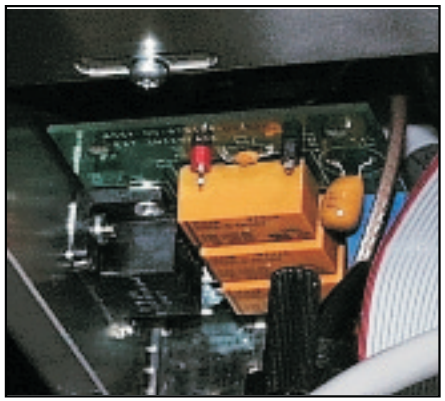
ON/OFF Pushbutton

External Interfaces

This paragraph discusses the External Interface PCB and Workstation rear panel. Refer to **Section 9 - External Interfaces** for detailed circuit descriptions, troubleshooting information, and component replacement instructions.

External Interface PCB

The External Interface PCB connects via ribbon cable to the System Interface PCB, which connects to ISA slot 2 on the Host Pentium CPU motherboard located in the **Electronics box**. As its name implies, the External Interface PCB connects the motherboard to the outside world. It provides DC isolation where necessary and adapts system signals to make them compatible with external equipment connected to the Workstation rear panel and Interconnect cable. In some cases, the External Interface PCB passes signals straight through without modification. In other cases it adds a simple pullup resistor or current-limiting resistor to a signal line. In other cases, the External Interface PCB uses an ISA bus signal to switch relay contacts. The External Interface PCB mounts directly behind the Workstation rear panel as shown below.



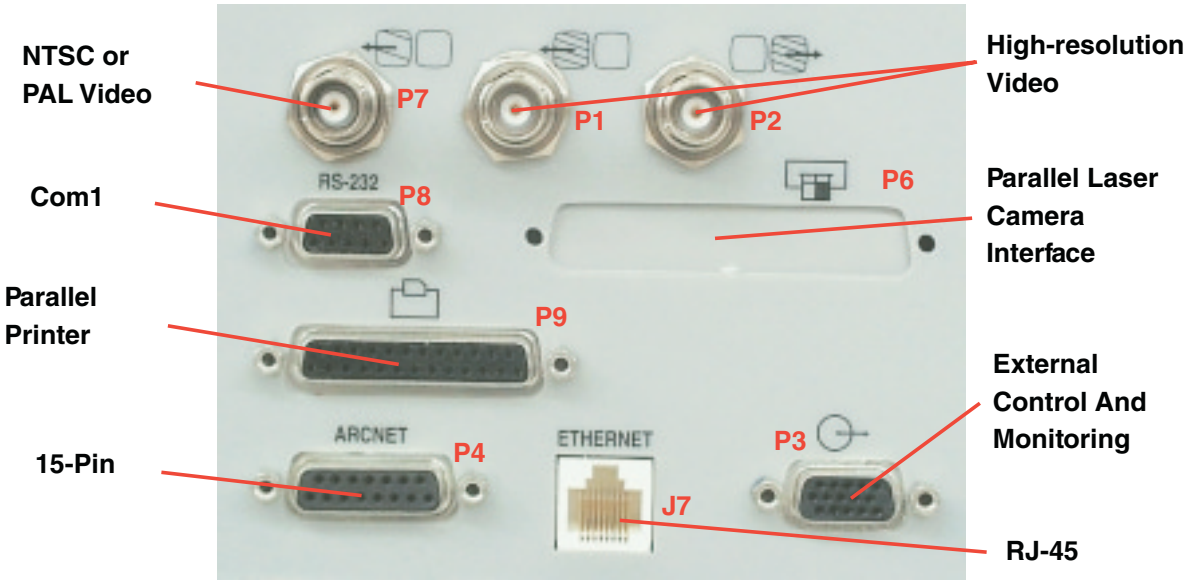
View inside electronics box directly behind rear panel connectors

External Interface PCB

Rear Panel Connectors

The following illustration shows the Workstation rear panel connectors.

Not all interfaces present on the Workstation rear panel pass through the External Interface PCB. For example, COM1 and LPT1 connect directly to the Host Pentium CPU, and the video signals come directly from the Display Controller.



Workstation Rear Panel Connectors

Power Distribution Subsystem

The Workstation Power Subsystem distributes AC and DC power to Workstation components, and may also provide AC power to externally attached equipment such as a C-Arm. Power Subsystem components include the power plug and cord, Surge Suppressor PCB, Isolation Transformer, AC circuit breakers, Power Control PCB, terminal blocks, AC line filter, cooling fans, and DC power supplies PS1 and PS2. These components are located throughout the Workstation. Refer to **Section 3 - System Power Distribution** for additional information.

System Software

System software that controls both the Workstation and the X-Ray generator resides on the Workstation's IDE Hard Disk Drive. The Workstation Host Controller subsystem normally boots from this drive.

OEC application software executes under the Nucleus® operating system. The OEC applications and operating system are both located in the non-DOS formatted 50 Mb portion of the hard drive.

File management and related utilities are located on the DOS-formatted section of the hard drive.

Boot Sequence

When you power up the Workstation, Host CPU software begins a step-by-step process of conducting power-on self tests (POSTs), establishing ARCnet interprocessor communications, and performing other tasks that prepare the system for use. This series of events is called the boot sequence. For a detailed description of the steps included in the boot sequence, refer to **Section 10 - Software**.

Status and Error Codes

If an error occurs during the boot-up process, an error message appears on the right-hand display. Refer to **Section 10 - Software** for a complete description of each status and error code.

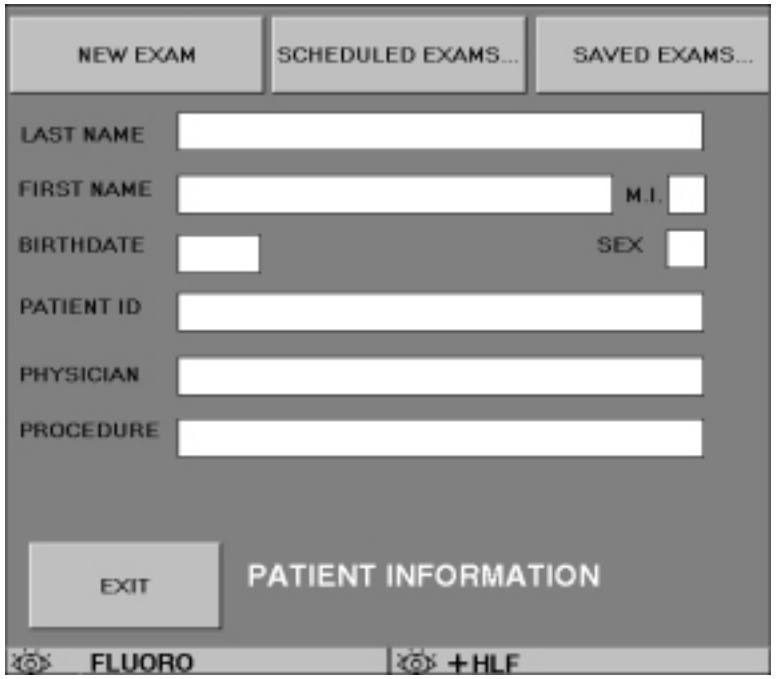
Run-time Error Reporting

Errors that occur during Workstation operation generate a message on the right-hand display and cause the Workstation software to cease operation. Run-time errors include DOS errors, I/O errors, critical errors, and fatal errors. For a description of the run-time errors most likely to affect Workstation operation, refer to **Section 10 - Software**.

Touch Screen Graphical Interface

Workstation software includes a comprehensive graphical user interface (GUI) that works with the **Touch Screen** hardware described above to allow you to select modes and features by touching a finger to the right-hand display screen.

The Patient Information screen, shown below, appears automatically after a successful Workstation boot-up.



Patient Information Screen

The Patient Information screen gives you four choices:

1. Touch **NEW EXAM** to enter information for a new patient.
2. Touch **SCHEDULED EXAMS** to display a list of patients who have not yet been examined.
3. Touch **SAVED EXAMS** to display a list of patients for whom images have been stored.
4. Touch **EXIT** to go to the Main Image screen

Each of the above choices displays another unique touch screen that requires further operator input. Nearly all system functions are available through the touch screen interface.

Please refer to the **OEC Workstation Operator's Guide** for complete information on how to use the Touch Screen interface. This is a paper document supplied with the Workstation.

Setup Utilities

The Host CPU motherboard has flash ROM BIOS that is preconfigured by OEC at the factory for the specific equipment and options supplied with each Workstation. When you add or replace Workstation equipment, follow the instructions you receive from the factory to update the BIOS.

Service Port

The ARCNET connector on the Workstation rear panel is a secure serial port reserved for customer technical personnel or OEC Field Service Engineers. It is used to configure, test and calibrate both the Workstation and X-Ray generator.

The service port uses a packet-based handshaking protocol to communicate with a remote computer. Usually the remote computer will be a laptop located a few feet away from the Workstation.

The remote computer becomes the server, downloading command and data packets to the Workstation client. The Workstation responds with an ACK when it successfully receives a packet, and with a NAK if it doesn't receive a complete packet within the timeout period. The remote computer resends the packet until it receives an ACK from the Workstation, and then sends the next packet. An upload from the client (the Workstation) consists of much the same protocol in reverse; the Workstation sends a packet, which the remote computer responds to with an ACK or NAK. In the event of a NAK, the Workstation resends the packet until its service port times out. A timeout of the service port terminates the remote session.

Refer to **Section 9 - External Interfaces** for complete hardware information on the Workstation's service port.

Remote Utilities

The Remote Utilities Software (RUT) is a suite of programs that execute on a remote computer, which communicates with the Workstation service port just described. RUT allows customer technical personnel and OEC Field Service Engineers access to the system for the following purposes:

- Setup
- Configuration
- Calibration
- Troubleshooting

Please refer to **Section 10 - Software** for additional details on the Remote Utilities.

Modes of Operation

The following paragraphs describe the six basic modes of operation for the OEC Workstation, including Fluoro, High-Level Fluoro, Digital Spot, Subtract, Roadmap, and Film. Only basic descriptions of these modes will be given here. For a complete description of how to enter and use each mode, refer to the **OEC Mobile Workstation Operator's Guide.** This is a paper manual that ships with the Workstation.

Fluoro

During Fluoro (fluoroscopic) mode, the Workstation displays live X-Ray images on the left-hand monitor (also known as the Primary Display). Technique (kVp and mA) control can be manual or automatic. A fluoro shot terminates and image acquisition ceases when the operator releases the X-Ray switch.

High-Level Fluoro

During High-Level Fluoro (HLF), fluoroscopic mA increases to reduce noise and improve image quality. The Workstation displays live X-Ray images on the left-hand monitor (Primary Display). Technique control (kVp and mA) can be manual or automatic. A high-level fluoro shot terminates and image acquisition ceases when the operator releases the X-Ray switch, or when the length of the exposure reaches a preset amount of time (20 seconds maximum).

Digital Spot

The Digital Spot mode creates short-duration HLF images to visualize dense anatomy. The Workstation automatically saves the image to the hard disk after each exposure. After you save the image to disk, you can apply image enhancements such as Noise Reduction, Sharpen, or Contrast/Brightness.

Subtract

Subtraction produces images that are the difference between a fluoroscopic image obtained while contrast media is present in a vessel and a mask image of the same anatomy obtained just prior to the subtraction process before injection of the contrast media. The subtracted image appears on the left-hand monitor. Subtraction is ideal for visualizing vasculature.

Roadmap

Roadmapping produces a series of subtracted images that are the difference between a fluoroscopic image obtained with a catheter present in a vessel, and a mask image obtained just prior to catheter insertion when a peak level of contrast media is present in the vessel. Roadmap images appear on the left-hand monitor. Because they clearly show catheter movement, Roadmap images are very useful in precise catheter placement.

Film

The Film mode automatically produces the correct technique to expose radiographic film.

Configurations

The Workstation is available in five basic configurations: Enhanced Surgical Platform (ESP), Enhanced Surgical Platform - Cine, Vascular, Neurovascular, and Cardiac.

Enhanced Surgical Platform

The Enhanced Surgical Platform (ESP) is the basic Workstation configuration around which the other Workstation configurations are built. The ESP includes the following features:

- Standardized, sealed keyboard
- Touch screen graphical user interface (GUI)
- Expanded external interface capabilities
- DICOM interface

When all options are installed, the ESP has the following capabilities:

- On-line help screens for system functions and features
- Image annotation
- Image directory that allows image selection by doctor, patient, or date
- Display of X-Ray dose information that includes shot type, date, time, mode, DAP, cumulative DAP, and technique
- Dose Log option that displays DAP, cumulative DAP, and modes used. Dose measurement may be set to microgray or rad
- Access special applications such as vessel measurement software
- Test pattern screen
- Customization screen for Auto Save and other functions

- Entry of date and time
- A VCR interface that allows images to be recorded to and played back from S-VHS cassette tape
- Zoom in and roam a region of interest on recorded images.
- Provide edge enhancement on LMON images
- Apply variable sharpening on static and real-time images
- Reverse image grayscale to represent a film negative
- Provide autohistogram image equalization
- Provide automatic and manual brightness and contrast control
- Provide mode selection interface to X-Ray generator that allows selection of fluoro and digital spot modes
- Apply noise filter (recursive averaging) to 2, 4, 8, or 16 frames
- Save any LMON image to hard disk
- Swap images between monitors
- Control cursor movement and mode selection with keyboard, touch screen GUI, or IR remote

Enhanced Surgical Platform -- Cine

This Workstation configuration includes the features and capabilities of the ESP Workstation described above, plus the ability to record images at 15 FPS (12.5 FPS at 50 Hz) for up to 5 minutes. The ESP has no digital subtraction or roadmapping capability.

Vascular

The Vascular Workstation has the same features as the ESP - Cine Workstation described above, plus the ability to perform digital subtraction and roadmapping. The Vascular Workstation also offers the Landmark feature that displays a variable percentage of background in a subtracted image, Mask Registration to realign a mask with a subtracted image, and Peak Opacification to improve the contrast of a subtracted image.

Neurovascular

The Neurovascular Workstation is similar to the Vascular Workstation, except that it has 30 FPS, 5-minute Cine capability. High-Level fluoro and the 30 PPS option are not available. The removable zip disk is an option.

Cardiac

The Cardiac Workstation offers 30 FPS, 5 minute Cine Disk capability, High-Level fluoro, and the removable zip disk as standard features. The 30 PPS option is also available in the Cardiac Workstation.

Options

The following optional equipment is available for the OEC Workstation.

Cine Disk

The Digital Cine option offers high technique levels for imaging small vessels and other anatomy that is in constant movement. The 15 FPS option stores high resolution images at up to 15 images per second (12.5 FPS at 50 Hz) for up to five minutes. The 30 FPS option stores images at up to 30 images per second (25 FPS at 50 Hz) for up to five minutes.

For more information, refer to **CINE DISK SUBSYSTEM**, which appears earlier in this section, or to **Section 6 - Cine Disk Subsystem**.

Measurement Software

This optional software feature allows a doctor to make linear or angular measurements of vessels, bones, and other anatomy. It is especially useful in orthopaedic and cardiac applications. For additional information the measurement software, refer to **Section 10 - Software**

Infrared Remote

The optional handheld infrared remote control is described and illustrated under **USER INTERFACES,** which appears earlier in this section. The infrared remote is available for all Workstation configurations.

Video Cassette Recorder

The VCR option includes a remotely-controlled, half-inch S-VHS tape machine and the power, control, and signal cables necessary to install the VCR in the Workstation. The VCR accepts down-scanned video from the Display Controller PCB in NTSC (RS-170) or PAL (CCIR) format. Although the VCR cannot record 1kx1k high resolution images, it offers much greater image storage capacity than a cine disk (two hours or more compared to five minutes maximum).

For a complete description of the VCR's video and control interfaces, refer to **Section 7 - Image Subsystem**

Video Cassette Recorder

SCSI Devices

The SCSI Controller PCB described previously in the **HOST CONTROLLER** paragraphs supports several optional devices, such as a removable media hard disk drive. The SCSI controller can support up to seven SCSI devices.

Removable Dynamic Digital Disk

The removable disk drive, located on the Workstation rear panel, is supplied as a standard feature on Cardiac Workstations, and is available as an option on others. The removable cartridge can hold about two gigabytes of data. The fast transfer rate and large storage capacity make it ideal for archiving cine runs.

Removable Media Hard Disk Drive

Hardcopy Camera

The hardcopy camera prints archived images on standard 8 x 10 inch X-Ray sheet film. It accepts IEEE 1284 compliant digital video from the Display Controller on a 25-pin D-type connector. It prints one or two images on each film sheet under program control.

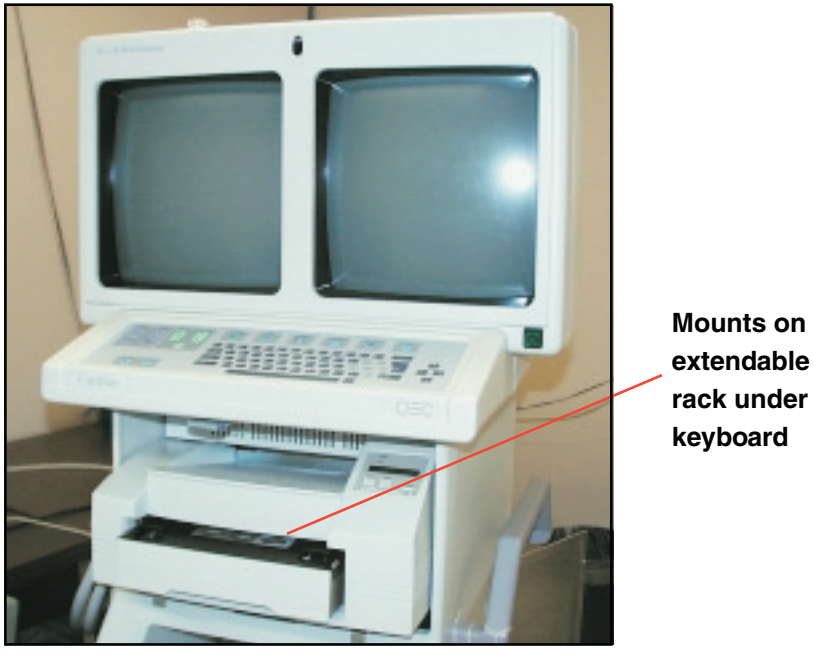
For complete information on the hardcopy camera interface, refer to **Section 7 - Image Subsystem**.

Hardcopy Camera

Instant Film/Paper Printer

The Instant Film/Paper Printer is a hardcopy output device that prints archived images on paper or transparency film at 300 dpi. The printer outputs 256 levels of grey. The printer accepts Centronics-compatible data from the Display controller on a 36-pin connector, and operates under program or front panel control.

For complete information on the Instant Film/Paper Printer interface, refer to **Section 7 - Image Subsystem**.



Instant Film/Paper Printer

Laser Camera Interface

The laser camera interface is an 8-bit ISA PCB that mounts in ISA slot 3 of the Host Pentium CPU motherboard. Under program control, this PCB transmits digital archived images over a 37-pin D-type connector to a remote laser imaging camera connected to the Workstation rear panel. The laser camera interface supports both the 3M MMU910 and Kodak Model 100 digital interface protocols.

For complete information on the laser camera interface, refer to **Section 7 - Image Subsystem**.

Laser Camera Interface

Thermal Printer

The thermal printer is a hardcopy device that accepts composite video (RS-170 or CCIR) from the Display Controller PCB to produce grayscale images on heat-sensitive paper. Image resolution is typically 256 scales of gray, with 1280 dots per line. The thermal printer requires manual control from a footswitch, remote control unit, or front panel controls. It can print a page in 10 seconds.

For a complete description of the composite video signals produced by the Display Controller, refer to **Section 7 - Image Subsystem**.

Typical Thermal Printer

Section 3 - Power Distribution

This section explains how the OEC Workstation develops its AC and DC operating potentials from AC line current and how it distributes the DC potential internally. This section covers the following topics:

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AC Electrical Requirements 3-4
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Line Regulation 3-4
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Cine Disk Power Supply PS2 3-59

References

Refer to the following Workstation block diagrams and schematics as you read this section:

- Workstation Interconnect Diagram 00-878981
- Surge Suppressor PCB Schematic 00-880538
- Power Control PCB Schematic 00-880315
- DC Distribution PCB Schematic - 00-879117

AC Electrical Requirements

AC line current for both the Workstation enters the power cord at the rear of the Workstation. The Workstation can be strapped for 91-128 VAC or 182-256 VAC single-phase operation, and is delivered with the correct power cord assembly for the customer's local AC service. For ease of communication, this manual refers to the two line voltage ranges as 115 VAC and 230 VAC.

Outlet Capacity

The Workstation must be connected to an outlet capable of providing at least 15 Amps at 115 VAC, or 8 Amps at 230 VAC.

Line Regulation

The AC outlet must be able to supply its nominal line voltage reliably at maximum current capacity, even during peak demand periods. Line voltage must not drop more than 15%.

Outlet Safety

WARNING: *Check the electrical outlet for open ground, open neutral, phase-to-neutral reversal, and improper line voltage before connecting the system to the outlet. Connecting the system to an improperly wired electrical outlet can result in death, personal injury, equipment damage, or improper equipment operation.*

Continuous AC

Note: *The Workstation AC power plug should be connected to a dedicated AC outlet. DO NOT connect the system to an AC outlet that is controlled by a wall switch, or one that is on the same breaker with appliances, electric motors, or other large or inductive loads.*

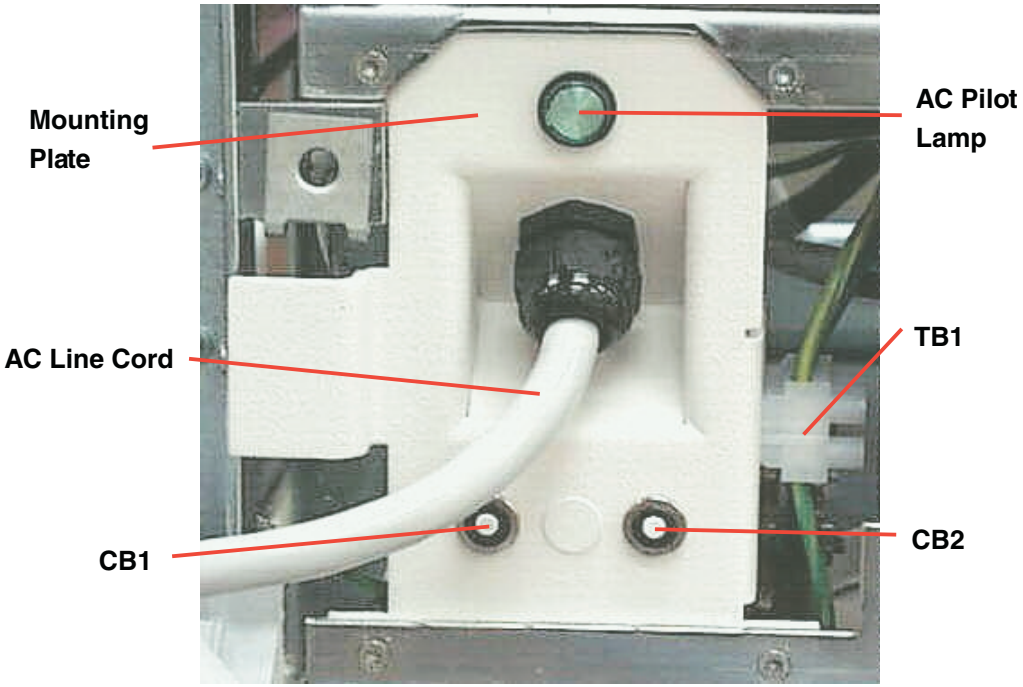
Note: *If a C-Arm is attached, keep the system plugged into the AC outlet at all times, even when it is not being used. C-Arms use lead acid storage batteries that must be constantly trickle charged to maintain their proper operating potential.*

AC Power Cord Assembly

Page 3 of the **Workstation Interconnect Diagram 00-878981** provides wiring diagrams for the Workstation power cord assemblies. Note that there is a separate power cord assembly for 115 VAC and 230 VAC operation. Each power cord assembly includes the power plug, power cord, a terminal block, one or two AC line circuit breakers, chassis ground wire and terminal, and AC pilot lamp assembly. Each component in the AC power cord assembly is field replaceable.

Location

Four torx screws secure the AC Power Cord Assembly mounting plate to the bottom left corner of the Workstation rear panel.



120 VAC Power Cord Assembly Mounting Plate

Removal and Replacement

Follow these steps to replace the AC Power Cord Assembly:

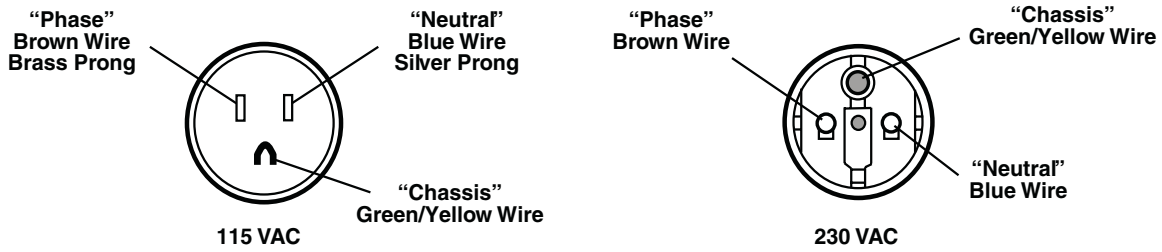
1. Inspect replacement AC Power Cord Assembly for obvious damage or missing components.
2. Disconnect AC plug from facility's AC outlet.
3. Remove Workstation rear cover.
4. Disconnect green/yellow chassis ground wire from TB1. Leave other end of wire connected to Surge Suppressor PCB.
5. Disconnect A38J1 from Surge Suppressor PCB.
6. Remove four torx screws that secure AC Power Cord Assembly mounting plate to Workstation rear chassis. Retain screws.
7. Lift AC Power Cord Assembly from Workstation.
8. Connect A38J1 on replacement AC Power Cord Assembly to P1 on Surge Suppressor assembly. Ensure connector locks in place.
9. Connect green/yellow chassis ground wire disconnected in step 3 to TB1-6.
10. Secure Power Cord Assembly mounting plate to Workstation rear chassis using torx screws removed in step 5.
11. Connect Workstation's AC power plug to facility's AC outlet.
12. Power up Workstation and check for proper operation.
13. Install Workstation rear cover.

AC Power Plug

The system has distinctly different power plugs for 115 VAC and 230 VAC operation. While each plug has phase, neutral, and chassis ground conductors, their physical configurations are not alike.

Types

The following illustration shows the two basic kinds of Workstation AC power plugs.



Workstation AC Power Plugs

WARNING: *Never operate the system without the AC plug's grounding prong in place. Failure to heed this warning may result in death, personal injury, equipment damage, or improper equipment operation.*

Removal and Replacement

Follow these instructions to replace the Workstation's AC line plug:

115 VAC Plug

1. Disconnect plug from AC outlet.
2. Loosen cord clamp setscrew.
3. Loosen two screws that secure plug collar around cord.
4. Separate plug collar from plug body. Pull plug body with attached cord through loosened collar far enough to expose three wire terminals on plug body.
5. Loosen three screws to disconnect cord wires from plug terminals.
6. Inspect cord wires for broken strands or cut insulation. If necessary, cut off damaged portion of cord and prepare wire ends by removing 1 inch (25 mm) of cord jacket and 1/4 inch (6 mm) of insulation from each cord conductor.
7. Inspect replacement plug for damaged or missing components.
8. Thread prepared AC line cord through collar on replacement plug.
9. Twist together strands on each line cord wire.
10. Insert green/yellow (ground) conductor into terminal for cylindrical ground prong. Push wire into terminal fully and secure setscrew.
11. Insert blue (neutral) wire into terminal for silver-colored flat prong. Push wire into terminal fully and secure setscrew.
12. Insert brown (line) wire into terminal for brass flat prong. Push wire into terminal fully and secure setscrew.
13. Press plug body into plug collar.
14. Secure two screws on plug collar.
15. Secure cord clamp on outer jacket of line cord. Ensure cord does not move under clamp.

230 VAC Plug

1. Disconnect plug from AC outlet.
2. Loosen setscrew that secures plug boot to plug body.
3. Separate plug boot from plug body. Pull plug body with attached cord through boot far enough to expose three wire terminals on plug body.
4. Loosen clamp that holds line cord to plug body.
5. Loosen three screws to disconnect cord wires from plug terminals.
6. Inspect cord wires for broken strands or cut insulation. If necessary, cut off damaged portion of cord and prepare wire ends by removing 1 inch (25 mm) of cord jacket and 1/4 inch (6 mm) of insulation from each cord conductor.
7. Inspect replacement plug for damaged or missing components.
8. Thread prepared AC line cord through boot from replacement plug and under loosened clamp on plug body.
9. Twist together strands on each line cord wire.
10. Insert green/yellow (ground) conductor into center terminal on plug. Push wire into terminal fully and secure setscrew.
11. Insert blue (neutral) wire into left-hand terminal. Push wire into terminal fully and secure setscrew.
12. Insert brown (line) wire into right-hand terminal. Push wire into terminal fully and secure setscrew.
13. Secure clamp over jacket on line cord. Ensure cord does not move under clamp.
14. Press plug body into plug boot.
15. Secure setscrew on plug boot.

AC Pilot Lamp

The green AC pilot lamp glows any time the system is connected to a normal, active AC power source. Unless it is physically damaged, the neon lamp normally lasts the life of the Workstation.

Location

The AC pilot lamp is located on the **Power Cord Assembly mounting plate** above the AC power cord strain relief.

Removal and Replacement

The AC Pilot Lamp is not available as a replacement part. If it fails, **replace the AC Power Cord assembly**.

AC Line Circuit Breakers

Reset-only circuit breakers protect Workstation AC inputs. 115 VAC Workstations have four breakers (CB1 through CB4) and 230 VAC Workstations have three circuit breakers (CB1, CB3, and CB4).

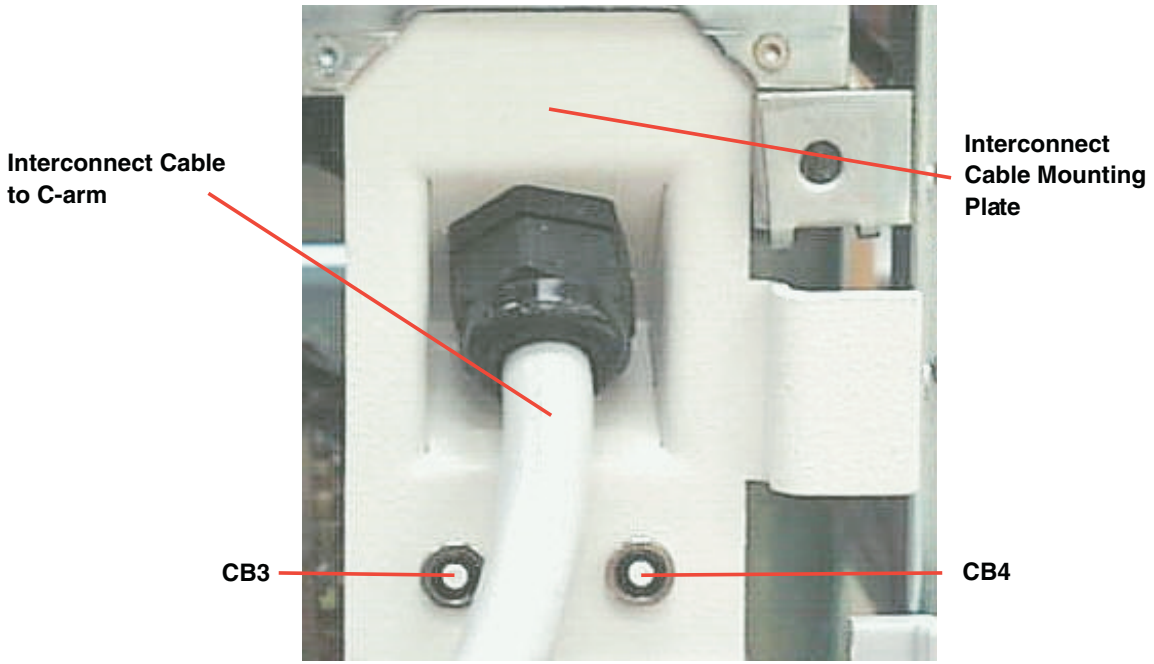
Location

CB1 mounts on the **AC Power Cord Assembly mounting plate** below the power cord strain relief. CB1 is a 20-Amp, reset only breaker in 115 VAC systems and a 10-Amp reset only breaker in 230 VAC systems.

CB2 is present in 115 VAC systems only, and mounts on the **AC Power Cord Assembly mounting plate** next to CB1. CB2 is a 10-Amp, reset only breaker that protects AC power to the two primary windings in the Isolation Transformer.

CB3, which mounts on the **Interconnect Cable mounting plate** below the interconnect cable strain relief, is a 10-Amp, reset only breaker that protects 115 VAC power.

CB4 mounts on the **Interconnect Cable mounting plate** below the interconnect cable strain relief. It is 5-Amp, reset only breaker that protects 230 VAC power to Workstation circuitry.



Interconnect Cable Mounting Plate

Troubleshooting

Replace a circuit breaker when it won't reset with the power off, or when it repeatedly trips with no obvious cause.

Removal and Replacement

WARNING: *AC line voltage is present on circuit breaker terminals. To avoid dangerous electrical shock, disconnect Workstation AC line plug from facility AC outlet before attempting to replace a circuit breaker.*

Follow these steps to replace CB1, CB2, CB3, or CB4:

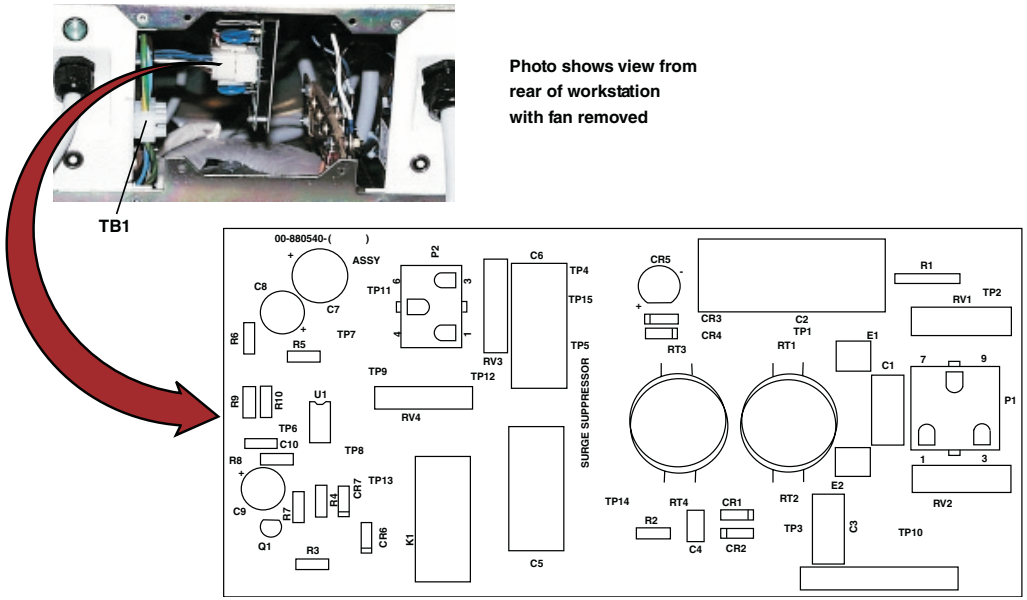
1. Disconnect AC power plug from facility's AC outlet.
2. Remove rear cover from Workstation.
3. Remove four torx screws that secure AC Power Cord mounting plate or Interconnect Cable mounting plate to Workstation chassis. Retain screws for reuse.
4. Disconnect and tag wires from circuit breaker to be replaced.
5. Carefully loosen and remove dress nut that secures circuit breaker to mounting plate. Remove circuit breaker from mounting plate.
6. Inspect replacement circuit breaker for obvious damage.
7. Connect wires disconnected in step #4 to replacement circuit breaker.
8. Mount replacement circuit breaker to mounting plate. Secure dress nut.
9. Use four torx screws removed in step #3 to secure mounting plate to Workstation.
10. Connect Workstation AC power plug to facility's AC outlet.
11. Test Workstation for proper operation.
12. Install Workstation rear cover.

Surge Suppressor PCB

The following discussion refers to the Surge Suppressor PCB shown next and to **Surge Suppressor PCB Schematic 00-880538**.

Location

The Surge Suppressor PCB mounts in the bottom cavity of the Workstation chassis above the Isolation Transformer as shown on the following page. It sits between the AC Power Cord Assembly mounting plate and the Interconnect Cable mounting plate directly in front of a cooling fan at the bottom rear of the Workstation chassis.



Surge Suppressor PCB

Circuit Description

The Surge Suppressor PCB protects the Isolation Transformer from gross overvoltage conditions, undervoltage conditions, surges, and spikes on the AC line.

Overvoltage Protection

Overvoltage protection circuitry consists of a range switch (Q1 and associated components), overvoltage lockout comparator (U1 and associated components), overvoltage lockout relay K1, and a charge pump +24 VDC power supply that operates these circuits.

Power Supply. A charge pump power supply generates the +24 Volts necessary to close relay K1 and transfer AC line current through the Surge Suppressor PCB to the Isolation Transformer. The +24 Volts also operates overvoltage lockout comparator U1. The power supply consists of R1, C2, bridge rectifier CR5, zener diode regulators CR3 and CR4, and electrolytic capacitor C7. The +24 Volts is present as long as the Workstation is plugged into an active AC outlet that supplies nominal AC line voltage.

***Note**: The +24 VDC from this supply references pin 3 of CR5, not chassis ground. Pin 3 of CR5 (and TP5) may be floating and should not be used for ground when measuring other potentials on the Surge Suppressor PCB.*

Overvoltage Lockout Comparator. The overvoltage lockout circuitry is most likely to see service if a Workstation wired for 115 VAC operation is accidentally connected to a 230 VAC source. U1 provides the overvoltage lockout. As long as U1-2 is sufficiently lower in potential than U1-3, pin U1-7 is low and K1 is energized. U1-3 stays at about 6 volts. U1-2 has a lower potential than U1-3 as long as the line voltage is normal. When the line voltage rises, however, the potential on U1-2 also rises, causing pin U1-7 to go high and K1 to de-energize.

Range Switch. Range switch Q1 turns on when the Workstation is powered by a 230 VAC source, keeping U1-2 at about the same potential it would have with the Workstation connected to a 115 VAC source.

Undervoltage Protection

The charge pump +24 Volt power supply's output drops when the line voltage sags. K1 drops out when line voltage drops to 70 VAC or below.

Spike Protection

RV1 is a 300-VAC metal oxide varistor (MOV) wired in series with gas discharge tube E1. The MOV and gas discharge tube together limit common mode voltage spikes between the neutral AC conductor and chassis ground to 800 Volts. RV2 and E2 provide similar common mode protection for spikes that occur between the line AC conductor and chassis ground. RV3 and RV4 limit line-to-neutral (normal mode) spikes to 400 volts. Capacitor C1 (.01uf) absorbs faster spikes before they reach RV3 and RV4. C5 and C6 (both .47uf) damp smaller pulses and spikes before RV3 and RV4 clip them.

Inrush Current Limiting

Thermistors RT1 through RT4 each have a cold resistance of about 2.5 ohms, which effectively limits inrush current at powerup. Thermistor resistance decreases to about .06 ohms as they reach operating temperature.

Test Points

WARNING: *Dangerous AC line voltage potentials are present on many Surge Suppressor PCB components and conductors. Probe all test points carefully. Replace the card with the AC power plug disconnected from the AC outlet.*

Normal operating potentials are as follows:

TP1 to **TP2** -- AC line voltage

TP3 to **TP10** -- 0 Volts

TP4 to **TP10** -- Pulses at AC line frequency

TP5 to **TP15** -- 24 VDC

TP6 to **TP5** -- less than +6 VDC

TP7 to **TP9** -- 6 VDC

TP8 to **TP9** -- .7 VDC

TP10 to **TP11** -- 0 Volts

TP11 to **TP12** -- 115 VAC

TP13 to **TP14** -- 115 VAC

TP15 to **TP5** -- +24 VDC

Circuit Breakers and Fuses

The Surge Suppressor PCB has no fuses or circuit breakers.

Troubleshooting

- One indication of an open thermistor in a 115 Volt system is an overheated isolation transformer and frequent tripping of CB2. Transformer overheating is caused by one primary winding being open and the other primary winding carrying the entire load.
- There is no easy way to test for an open MOV or nonconductive gas discharge tube. If you suspect a failure of one of these components or see evidence of component overheating or damage, replace the Surge Suppressor PCB.
- If CB1 trips immediately when you plug in the power cord, look for a shorted MOV or capacitor.
- If 24 VDC power supply fails, K1 does not close, making the entire system inoperative.
- If you find a faulty component on the Surge Suppressor PCB, replace the board.

Removal and Replacement

Follow these steps to replace the Surge Suppressor PCB:

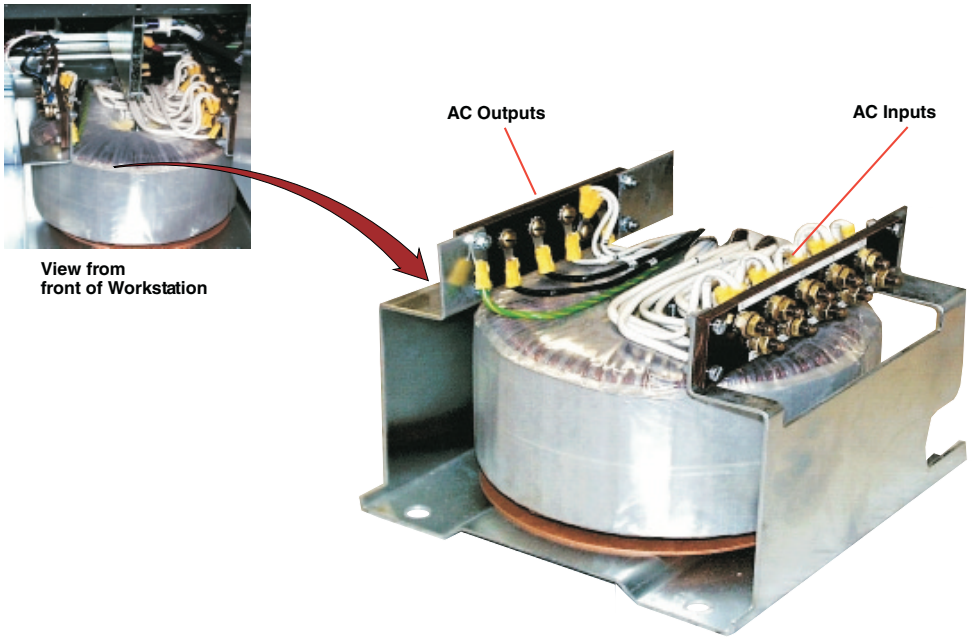
1. Disconnect AC power plug from facility's AC outlet.
2. Remove Workstation rear cover.
3. Remove four torx screws that attach Surge Suppressor PCB to chassis bracket. Save mounting hardware for reuse.
4. Disconnect connectors from P1 and P2 and tag both connectors.
5. Inspect replacement Surge Suppressor PCB for any obvious damage or missing components.
6. Reinstall tagged connectors to P1 and P2 on the new Surge Suppressor PCB.
7. Mount new PCB on chassis bracket and secure mounting hardware.
8. Connect AC power plug to facility's AC outlet.
9. Check system for proper operation.
10. Reinstall Workstation rear cover.

Isolation Transformer

The following paragraphs describe the AC power Isolation Transformer.

Location

The Isolation Transformer mounts on the bottom of the Workstation chassis below the Surge Suppressor PCB. The Isolation Transformer assembly includes the large, donut-shaped toroid, an input terminal strip, an output terminal strip, a mounting bracket, and mounting hardware.



Isolation Transformer

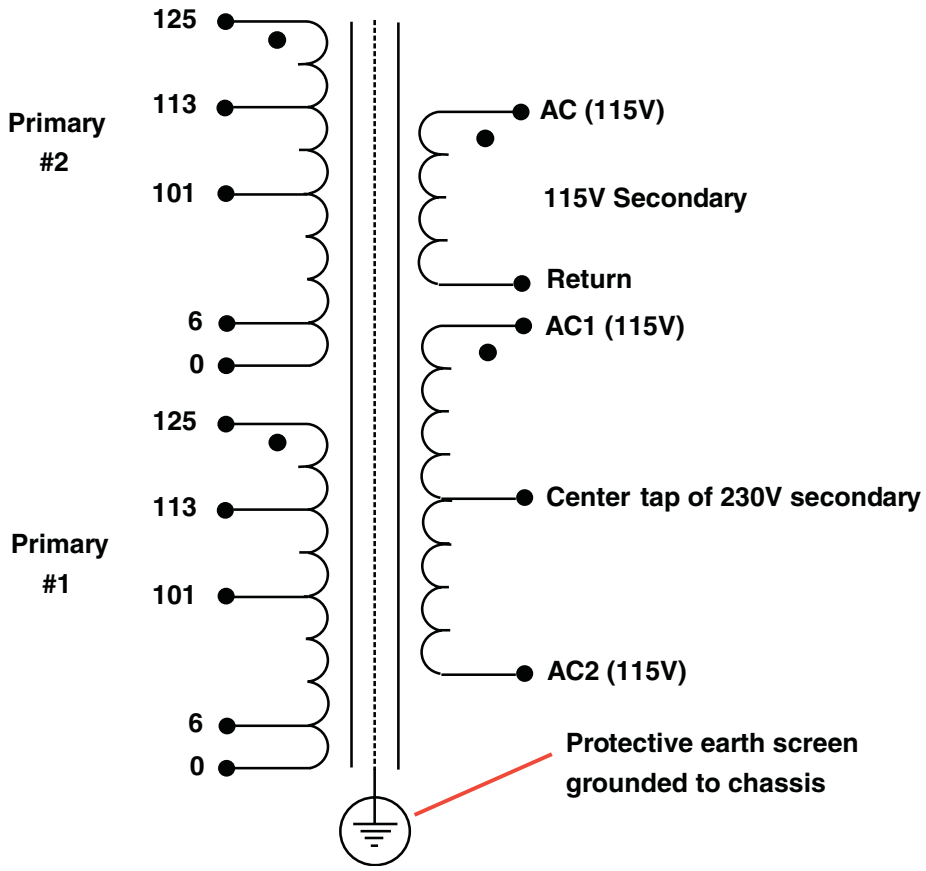
Circuit Description

The isolation transformer performs two functions. First, it provides DC isolation of the Workstation from the AC line. Next, it transforms the line voltage to the levels necessary to operate the Workstation. The transformer has two identical multi-tapped primary input windings that can be closely matched to the existing AC line voltage. The AC line cord assembly for 115 VAC applies power to the primary windings in parallel. The line cord assembly for 230 VAC applies power to the primary windings in series. The transformer has two secondary windings: a 115-Volt secondary winding which can power external equipment such as a C-Arm and a 230-Volt center-tapped secondary winding that powers the Workstation. A safety shield covers the entire transformer and connects to the Workstation's chassis ground via a green/yellow 18 AWG wire.

Test Points

Use the isolation transformer's input and output terminals shown on the following screen to make voltage and resistance checks when it is necessary to troubleshoot the transformer.

WARNING: *Dangerous AC line voltages are present on the isolation transformer's input and output terminals. Use great care when making voltage checks. When possible, troubleshoot the transformer using continuity and resistance checks with the AC power OFF.*



Isolation Transformer Schematic

***WARNING**: Dangerous AC line voltages are present on the isolation transformer's input and output terminals. Use great care when making voltage checks. When possible, troubleshoot the transformer using continuity and resistance checks with the AC power OFF.*

Circuit Breakers and Fuses

The isolation transformer has no internal circuit breakers or fuses.

Troubleshooting

***WARNING**: Make following checks with system's AC power plug disconnected from facility's AC outlet.*

The isolation transformer is very rugged and conservatively rated, so its failure during normal system operation is highly unlikely. However, you must replace the isolation transformer when it exhibits any of the following problems:

- Open primary or secondary winding
- Two or more windings shorted to each other or to the transformer core
- Winding shorted to shield or winding shorted to isolation transformer safety ground
- A winding shorted internally. Each primary winding should have a DC resistance of about .250 ohms. The 115-Volt secondary should have a DC resistance of about .28 ohms. The 230-Volt secondary's DC resistance should be about .83 ohms.
- Obvious mechanical damage
- Obvious damage from overheating

Removal and Replacement

***CAUTION**: The isolation transformer assembly is heavy. Get assistance when removing or installing it.*

1. Disconnect AC power plug from AC outlet.
2. Remove Workstation covers.
3. Without disturbing any wires that go to the transformer itself, disconnect all external wiring from input terminal strip and output terminal strip. Tag each wire as you disconnect it.
4. Remove four nuts and four washers that secure transformer bracket to Workstation chassis. Retain this hardware for reuse.
5. Carefully lift isolation transformer assembly from chassis and set it aside.
6. Inspect replacement isolation transformer assembly for any obvious damage or missing components.
7. Install replacement isolation transformer assembly in chassis. Orient bracket so that the two open screw slots face rear of chassis.
8. Install and secure nuts and washers removed in step 3.
9. Reinstall wires removed in step 3. Double check wiring and secure nuts.
10. Connect AC power plug to AC outlet and test system for proper operation.

Calibration

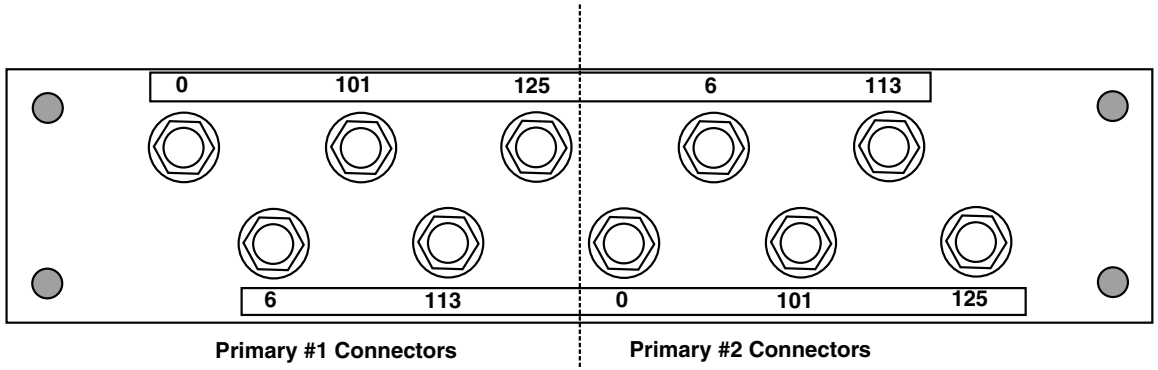
Calibration of the isolation transformer is the process of selecting the taps on each primary winding that most closely match the existing AC line voltage. Calibration may be necessary when the system is moved, when another device is added to or removed from the system's AC branch circuit, when the facility's AC wiring changes, or when there are major changes in the local electrical utility grid. Follow these steps to calibrate the isolation transformer:

***WARNING**: Use care when performing the following line voltage measurement. AC line voltage is dangerous.*

***Note**: Measure the line voltage at the time of day and on a day of the week when the imaging system is most likely to be used. AC line voltages tend to rise during non-peak hours.*

1. Turn off system and disconnect AC plug from facility's AC outlet.
2. Disconnect any other plug which may be connected to facility's AC outlet.
3. Use accurate digital multimeter to measure line voltage at AC outlet. If line voltage measures between 182 and 256 Volts, divide this number by two and record it to the nearest tenth of a volt. If line voltage measures between 91 and 128 Volts, record this value to the nearest tenth of a volt.
4. Remove Workstation covers.

5. Identify the set of AC input terminals for each transformer primary input winding. Note that primary #1's terminals are on the left end of the AC input terminal strip, and primary #2's terminals are on the right end, and both sets of terminals are identical. The input terminal strip appears as follows:



Isolation Transformer AC Input Terminal Strip

6. Follow instructions in table to connect two AC input lines to each primary winding.

Isolation Transformer AC Inputs

If AC line voltage measures	Connect white/blue wire to Primary #1 Terminal	Connect brown wire to Primary #1 Terminal	Connect blue wire to Primary #2 Terminal	Connect white/brown wire to Primary #2 Terminal
92.0 to 97.9	6	101	6	101
98.0 to 103.9	0	101	0	101
104.0 to 109.9	6	113	6	113
110.0 to 115.9	0	113	0	113
116.0 to 121.9	6	125	6	125
122.0 to 128.0	0	125	0	125

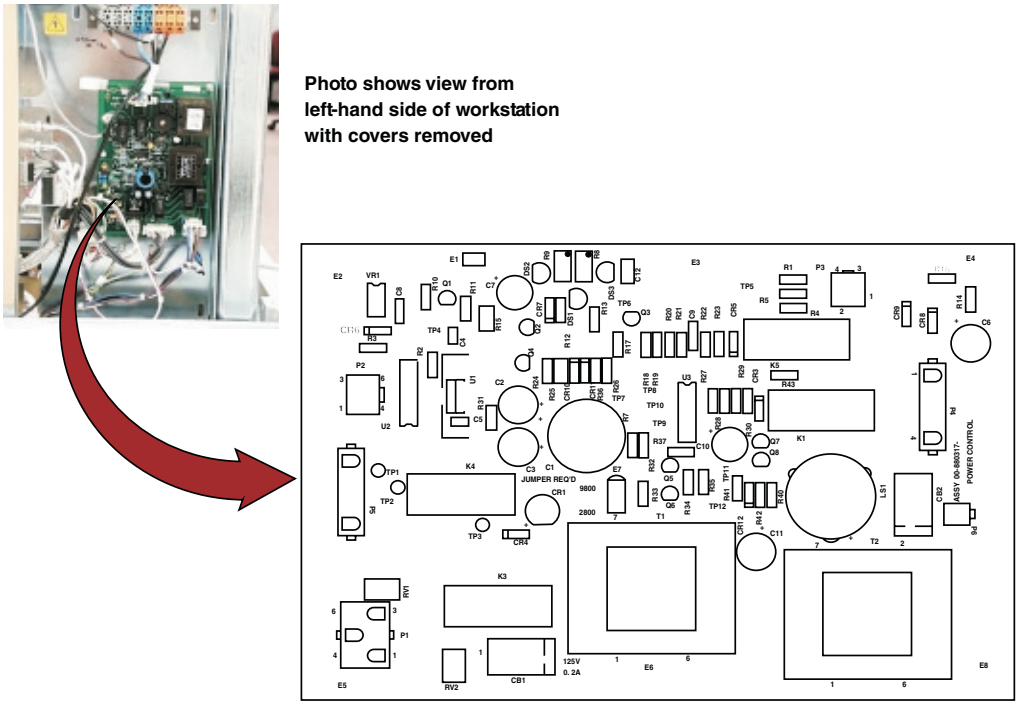
7. Connect AC plug to facility's AC outlet and check system for proper operation.
8. Install Workstation covers.

Power Control PCB

The following paragraphs describe the Power Control PCB. Please refer to **Power Control PCB Schematic 00-880315** while reading this material.

Location

The Power Control PCB is accessible on the lower left-hand side of the Workstation chassis under the left cover.



Power Control PCB

Circuit Description

The following discussion refers to the assembly drawing shown above, to **Workstation Interconnect diagram 00-878981**, and to **Power Control PCB schematic 00-880315**.

Overview

The Power Control PCB uses an Interconnect Cable loop circuit and electromechanical relays to ensure safe distribution of 115 VAC power from CB3 and the distribution of 230 VAC from CB4. The board is also equipped with a window comparator/delay circuit that prevents application of AC power to system circuitry when the line voltage is initially too high or too low, and an audible alarm that sounds when an abnormal line voltage condition prevents normal system power-up.

LOOP and CNCT_ON

The LOOP and CNCT_ON circuits prevent distribution of AC power to external equipment, such as a C-Arm, when the interconnect cable from the Workstation is not properly connected. This helps prevent accidental electric shock from exposed connector terminals.

LOOP. The LOOP circuit consists of a simple wire loop through the interconnect cable which is completed when the interconnect cable is connected.

Relays

The Power Control PCB has four relays, all shown on sheet 1 of the schematic. K1 transfers 230 VAC to Workstation circuitry through P4. K1 also transfers 115 VAC to T2, which generates 10 VAC for the modem. There is no K2. K3 and K4 transfer 115 VAC to external equipment such as a C-Arm, when they are energized. When they are not energized, K3 and K4 ground the AC power pins on the interconnect cable. K5 routes +12 Volts to the Workstation ON/OFF pushbutton (the 12V KEY signal) under normal conditions when it is not energized, or to the audible alarm during AC brown-out or overvoltage conditions.

DC Power Supplies

The DC power supply consisting of T1, full-wave bridge rectifier CR1, and regulator U1 generates +12 Volts, which is present as long as the system power plug is in an active AC outlet. The +12 Volts energizes power distribution relays K1, K3, and K4, and powers VR1, which generates a +10.000-Volt precision reference for the window comparator/delay circuitry shown on schematic sheet 2.

Delay/Window Comparator Circuit

When +12 Volts first appears on the Power Control PCB, C10 (schematic sheet 2) charges to +12 Volts in about 470 ms. This keeps Q3 turned off long enough for the window comparator circuit (composed of the upper two comparators in U3) to stabilize and check the AC voltage from the isolation transformer. (CR9, CR8, and C5 provide a DC equivalent of the AC isolation transformer voltage to the window comparator.) After the 470 ms delay, Q3 turns on, enabling Q1 to turn on also if the window comparator determines it's necessary to interrupt AC power to system circuitry. If the AC from the isolation transformer is too high or too low, Q1 turns on, asserting the *Relay_ON signal, which energizes relay K5 (schematic sheet 1). The window comparator circuit lights red LED DS3 if the AC voltage is too high, the amber LED DS2 if the AC voltage is too low, or green LED DS1 if the AC voltage is within range. When K5 energizes, it disconnects +12 Volts from P3-1, making it impossible to turn the Workstation on with the ON/OFF pushbutton. K5 applies the disconnected +12 Volts to the alarm circuit shown at the bottom center of schematic sheet 1. When K5 energizes, it also grounds U2-14, which deenergizes K3 and K4, preventing any AC power from reaching the external equipment.

Audible Alarm

K5 supplies +12 volts to the alarm when AC power from the isolation transformer is too high or too low. After C11 in the alarm circuit charges (in about 500 ms) the alarm sounds. (The 500 ms delay prevents the alarm from sounding during momentary power outages, and when the system is first plugged in.)

***Note**: Do not attempt to adjust potentiometers R8 or R9. They are factory set.*

***Note**: The Window Comparator/Delay circuit shown on schematic page 2 functions only when you first connect the system to an AC outlet, or after a power interruption that lasts half a second or longer.*

Normal Operation

If the Window Comparator/Delay circuit described above determines AC power from the isolation transformer is within limits, +12 volts exits the Power Control PCB through de-energized K5-2 to P3-1, and travels (as the 12V KEY signal) to the Workstation ON/OFF pushbutton.

When you set the ON/OFF pushbutton to ON, the +12 volts returns to the Power Control PCB on P3-2 (as the KEY_PWR signal). This +12 volts through the ON/OFF pushbutton energizes K1, which supplies 230 VAC to the Workstation.

Relays K3 and K4 supply 115 VAC power to external equipment, but only when they are energized. Note that the positive ends of both relay coils tie directly to +12 volts, so the relays only need a ground to turn them both on. U2 supplies this ground, provided the interconnect cable is in place. A properly installed interconnect cable supplies a ground to U2-1, forcing U2-16 high. This high charges C3 in about 500 ms, which forces U2-15 and U2-3 low. The resulting high on U2-14 propagates through a jumper from E7-1 to E7-2, forcing U2-4 and U2-5 high. U2-12 and U2-13 both go low, driving P2-1 (LOOP2) low. This low travels through the interconnect cable to the external equipment, where it loops back to the Workstation, arriving on P2-3 (LOOP1). The low turns on K3 and K4, supplying 115 VAC power to external equipment. The time delay introduced by U2 ensures there is time to firmly seat the Lemo connector before AC power reaches the external equipment.

***Note**: The jumper at E7 must be installed between pins 1 and 2, or the delay circuit described above WILL NOT work.*

Test Points

***WARNING**: Dangerous voltages are present on some of the following test points.*

The Power Control PCB has a number of useful test points. Normal operating potentials are:

TP1 to **TP2** -- 115 VAC

TP3 to **TP6** -- +12 VDC

TP4 to **TP6** -- +10.000 VDC

TP5 to **TP6** -- +12 VDC

TP8 to **TP6** -- +7.31 VDC

TP10 to **TP6** -- +5.39 VDC

TP11 to **TP6** -- +4 VDC

TP12 to **TP6** -- +1.4 VDC

Circuit Breakers and Fuses

The Power Control PCB has two circuit breakers and no fuses.

CB1 is a .2-Amp reset only circuit breaker that protects the +12 VDC power supply.

CB2 is a .2-Amp reset only circuit breaker that protects T2, which supplies 10 VAC to the modem.

Troubleshooting

- If CB1 opens, U1 fails, or VR1 fails, the entire system will fail to operate. The only activity indicator will be a green AC pilot light glowing on the Workstation rear panel.
- If CB2 is open or T2 fails, the modem won't work.
- If K1 fails open, 230 VAC power will not be applied to Workstation components. If K1 fails closed, the system will continue to operate, but the Workstation ON/OFF pushbutton will not turn off AC power.
- If K3 or K4 fail open, no AC power will reach the external equipment. If K3 and K4 both fail closed, the safety interlock circuitry won't work. This is a very unlikely scenario.
- If K5 fails open, the system will continue to operate, but it will be unprotected from overvoltage or undervoltage problems. If K5 fails closed, the audible alarm will sound and neither the Workstation nor the external equipment will receive AC power.
- If U3 fails, the window comparator and associated delay circuit won't work. Depending on the nature of the U3 failure, K5 may or may not be energized.
- If you find a failed component on the Power Control PCB, replace the board.

Removal and Replacement

1. Disconnect AC power plug from facility's AC outlet.
2. Remove lower left-hand Workstation cover.
3. Remove six screws that attach Power Control PCB to chassis. Retain six screws associated hardware for reuse.
4. Disconnect and tag connectors from P1 through P5.
5. Inspect replacement Power Control PCB for any obvious damage or missing components.
6. Re-connect P1 though P5 to replacement board.
7. Mount replacement PCB to chassis and secure mounting hardware.
8. Connect AC power plug to AC outlet.
9. Check system for proper operation.
10. Install Workstation cover removed in step 2.

Calibration

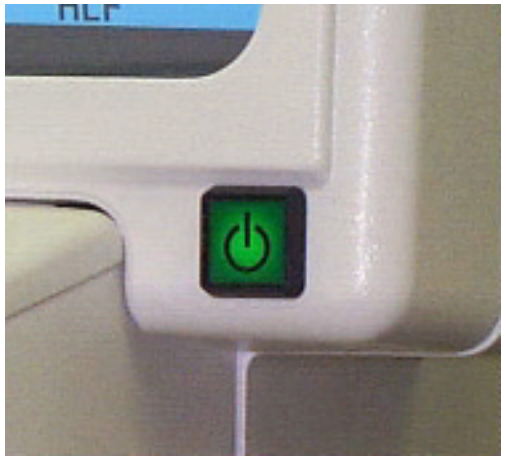
No adjustments are necessary after replacing the Power Control PCB.

Lighted ON/OFF Pushbutton

This paragraph describes the Workstation's lighted ON/OFF pushbutton that controls the application of AC power to Workstation circuitry. The pushbutton has an incandescent bulb that lights when AC power is applied. A nut behind the monitor bezel secures the pushbutton to the Workstation.

Location

The lighted ON/OFF pushbutton is located just below and to the right of the right-hand monitor (secondary display).



Lighted ON/OFF Pushbutton

Removal and Replacement

Follow these steps to replace the Workstation's ON/OFF pushbutton:

1. Disconnect AC power plug from facility's AC outlet.
2. Remove Monitor cover.
3. Carefully pull switch cable's faston connectors from pushbutton terminals.
4. Loosen threaded collar that holds pushbutton to monitor bezel.
5. Pull pushbutton through front of Workstation chassis.
6. Inspect replacement pushbutton for obvious damage or missing components.
7. Use ohmmeter to identify switch and bulb terminals on replacement pushbutton assembly.
8. Position pushbutton's flexible gasket so hole in gasket fits over index pin on pushbutton.
9. Place new pushbutton assembly in Workstation chassis mounting hole.
10. Install threaded collar on pushbutton and secure pushbutton to Workstation chassis as shown in above illustration.
11. Connect orange and red wires in switch cable to switch terminals on pushbutton assembly.
12. Connect black and green wires in switch cable to bulb terminals on pushbutton assembly.
13. Connect AC power plug to facility's AC outlet.
14. Test replacement pushbutton for proper operation.
15. Install Monitor cover.

Terminal Blocks

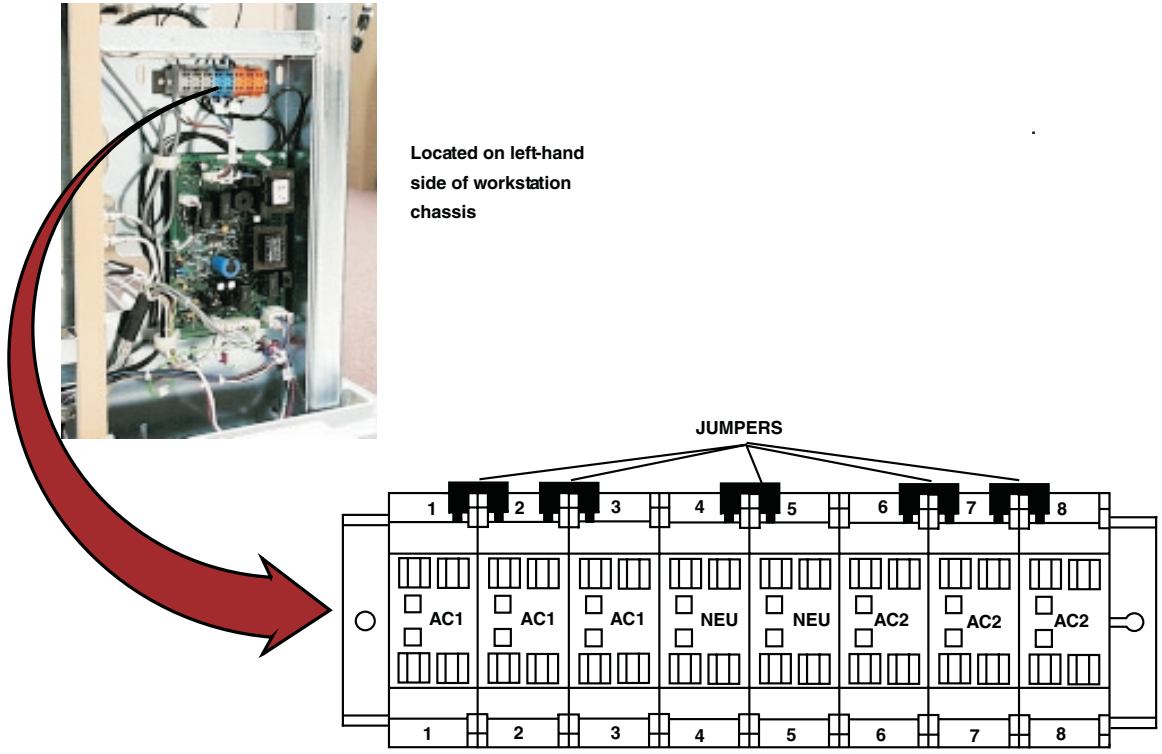
There are five terminal blocks that distribute AC power from the Power control PCB to Workstation circuitry. The terminal blocks appear on sheets 1, 3, and 4 of the **Workstation Interconnect Diagram 00-878981**.

TB1

TB1, which is part of the **AC Power Cord Assembly mounting plate** located in the lower left-hand corner of the Workstation rear panel, is the entry point for AC line voltage into the system.

TB2

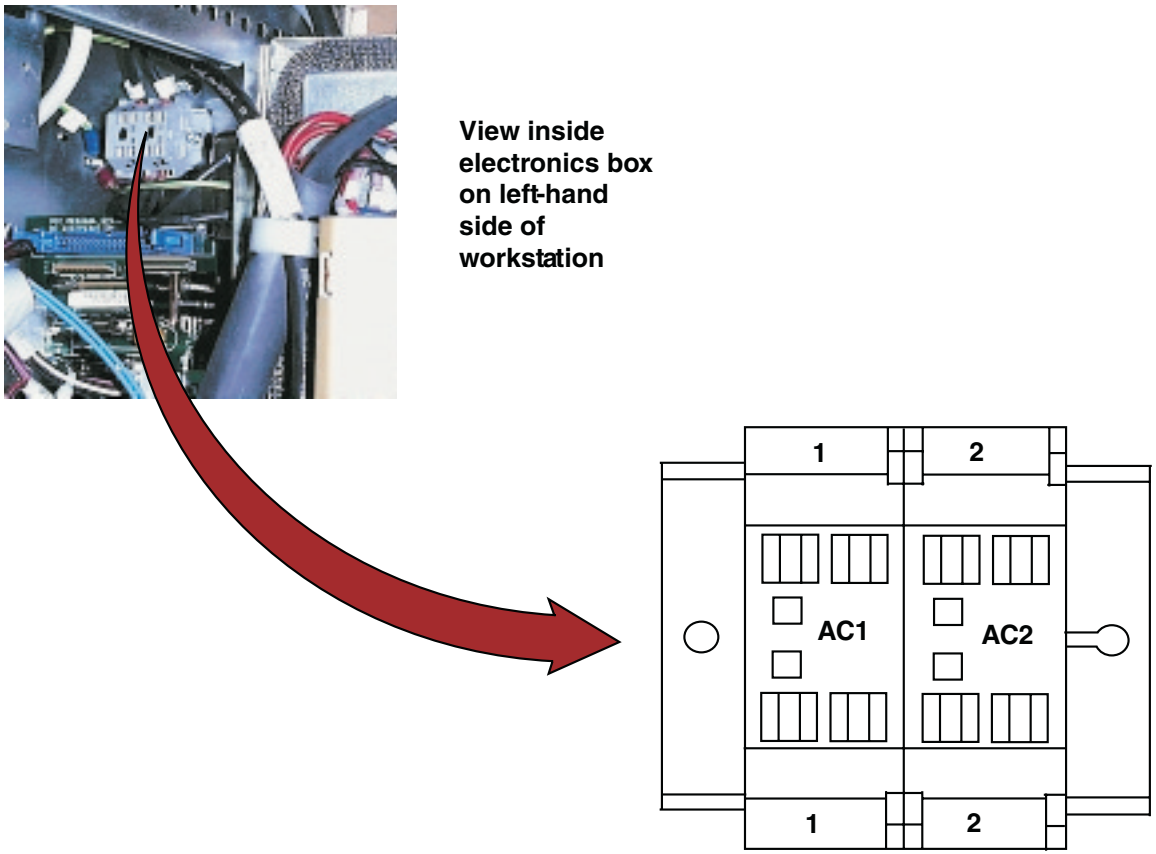
TB2 is located just above the Power Control PCB on the lower left-hand side of the Workstation chassis. TB2 accepts 230 VAC with ground from the Power Control PCB. TB2 distributes 115 VAC power to cooling fans B2 and B3. It also distributes 230 VAC power through LF1 to TB3, and 230 VAC with neutral to TB4.



TB2

TB3

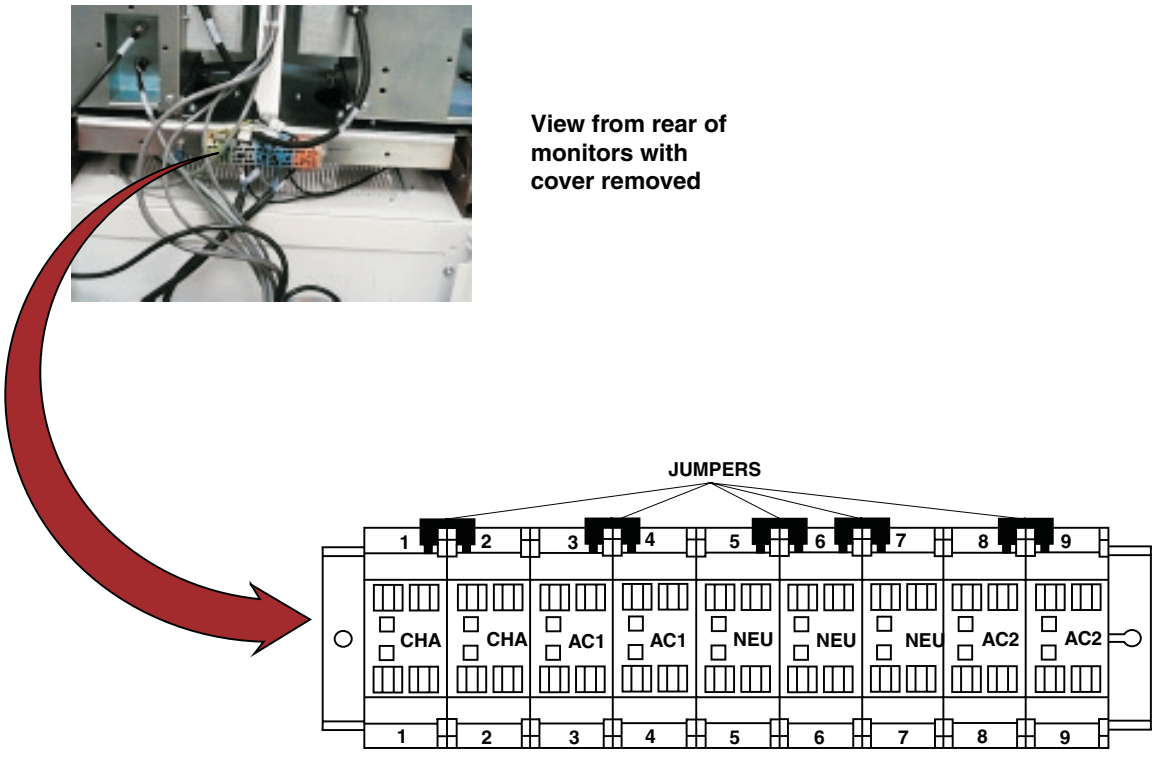
TB3 is located inside the Workstation Electronics Box on the rear wall near the top. TB3 distributes 230 VAC to the optional Cine 4-Disk Backplane assembly and to DC Power Supply PS1.



TB3

TB4

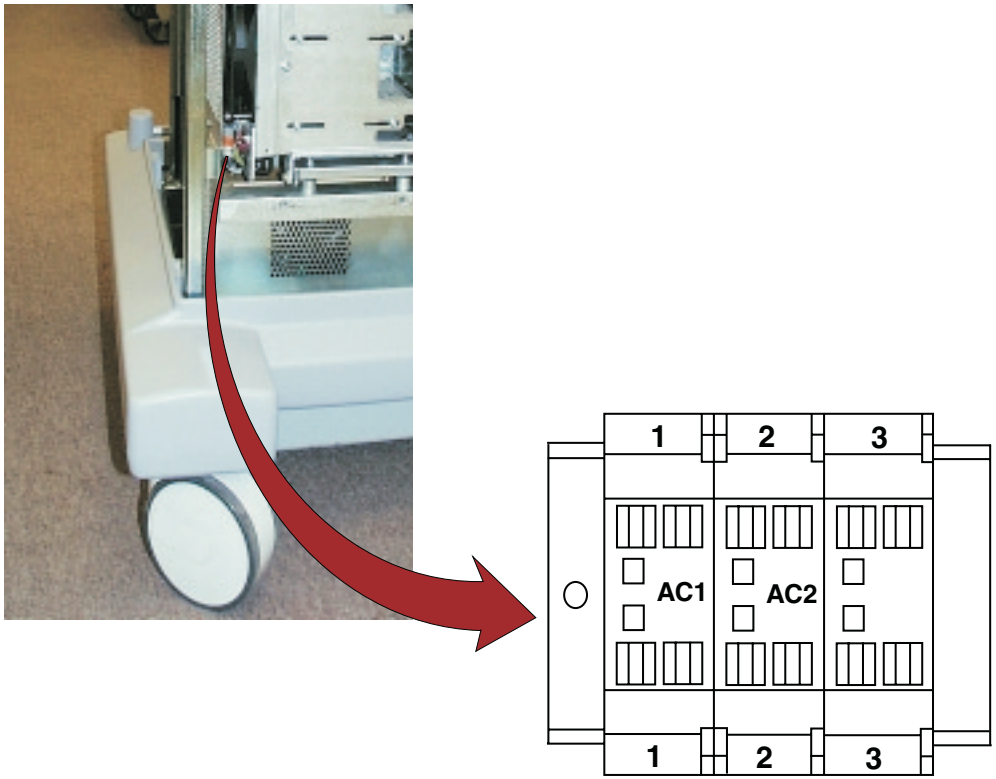
TB4 is the large terminal block just below the two monitor assemblies on the rear of the Workstation chassis. TB4 accepts 230 VAC with neutral from TB2. TB4 distributes 115 VAC to the two high resolution monitors, 115 VAC to the Elapsed Time Indicator, and 115 VAC to fans B4 and B5.



TB4

TB5

TB5, located inside the optional Cine 4-Disk assembly, accepts 230 VAC from TB3 and distributes this power to cooling fans and to DC power supply PS2.



TB5

DC Power Distribution

Workstation Interconnect Diagram 00-878981 shows the Workstation's DC power distribution circuitry. In addition to PS1 (sheet 4) and PS2 (sheet 1), several Workstation PCBs have DC power supply circuits that generate the potentials necessary to operate their internal circuitry. Refer to individual PCB circuit descriptions elsewhere in this manual for information on these power supplies.

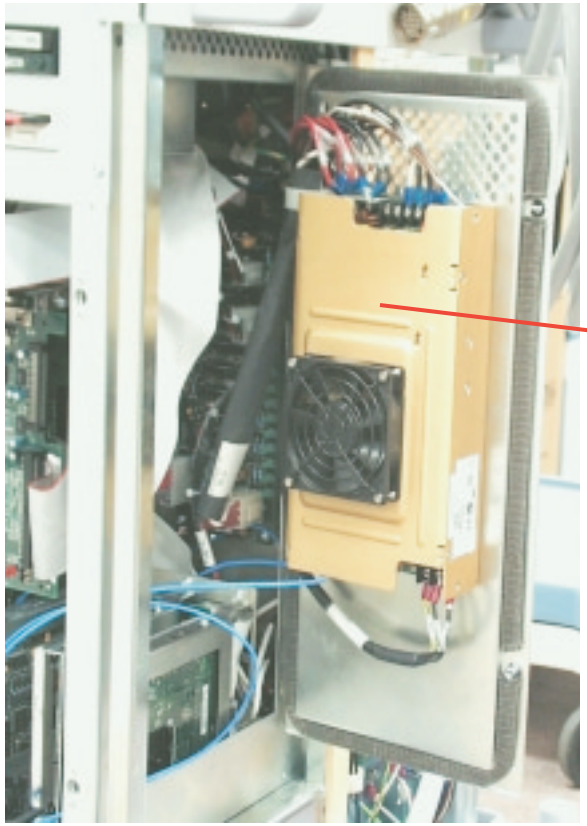
DC Power Supply PS1

PS1 generates +5 VDC at 35 Amps, +12 VDC at 10 Amps, 5 to 25 VDC at 6 Amps (not used), and -12 VDC at 6 Amps. The DC Power Distribution PCB routes these potentials to Workstation circuitry.

Location

PS1 mounts on the lower left-hand side of the Workstation chassis behind a swing-out panel. Remove the Workstation cover and loosen the two quarter-turn fasteners that secure the

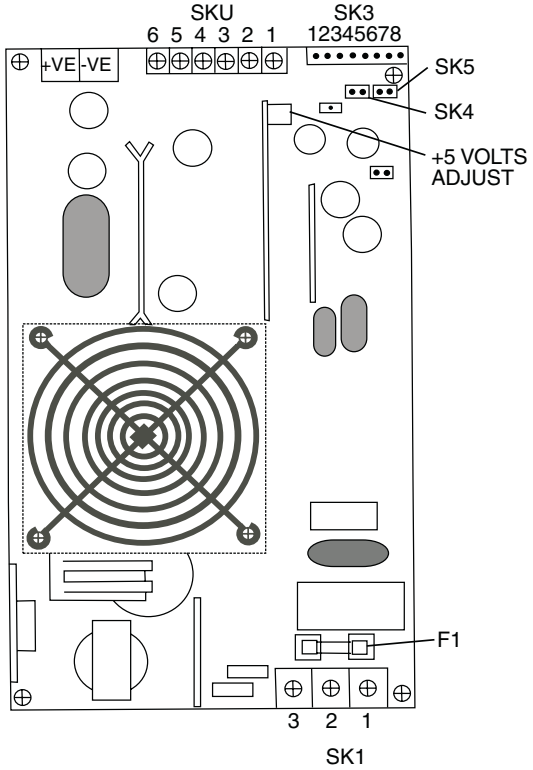
swing-out panel to gain access to the supply.



DC Power Supply PS1

Circuit Description

This discussion refers to the following assembly drawing, which shows PS1 with its cover removed. A schematic diagram for the power supply is not available.



PINS USED

SK1	PIN 1	NEUTRAL
	PIN 2	LINE
	PIN 3	GROUND
SK2	PIN 1	+12 VOLTS
	PIN 2	COMMON
	PIN 3	COMMON
	PIN 4	+12 VOLTS
SK3	PIN 7	POWER FAIL (TTL LOW)
SK4	PIN 1	+12 VOLTS @ 500 MA (FAN)
	PIN 2	GROUND

F1 IS 4A @ 250V FAST BLOW

PS1 Controls and Connectors

AC Input (SK1)

The System DC Power Supply (PS1) is a multi-output, switch mode supply powered by 230 VAC from the Isolation Transformer. AC Power travels from the Isolation Transformer through CB4 to P1 on the Power Control PCB. AC Power exits the Power Control PCB on P4, and travels through TB2, LF1, and TB3 to SK1 on PS1.

Overload Protection

PS1 is fully protected against short circuit and output overload. Recovery after a short circuit or overload fault is automatic.

Overvoltage Protection

Occurs when +5V output is between +5.7 to +6.7 VDC. Protection occurs on other outputs when they are 10% to 25% above nominal levels.

Thermal Overload Protection

The power supply shuts down all outputs when the chassis temperature becomes excessive. Recovery is automatic after the chassis cools.

Power Fail Indicator

PS1 outputs a TTL low on SK3-7 when it senses an AC power brownout condition. This happens at least 4 ms before loss of regulation. The **DC Power Distribution PCB** accepts the Power Fail signal on J4-13 and routes it through J5-15 to J5 on the **System Interface PCB** for further processing.

Voltage Adjustment

Only the 35-Amp +5 Volt output on PS1 is manually adjustable. The adjustment range is 4.75 to 5.25 Volts.

+VE/-VE

These two terminals provide 5 Volts DC at 35 Amps.

SK2

This connector provides the +12 Volts at 10 Amps, and -12 Volts at 6 Amps.

SK3-7

This connector provides the Power Fail TTL signal to the System Interface PCB

SK4 and SK7

These two connectors each provide 12 Volts at 500mA. The DC fan on PS1's cover normally connects to SK4.

Test Points

***WARNING**: Dangerous AC line voltage is present on SK1.*

There are no designated test points on PS1. Make input AC voltage measurements on connector SK1, and DC voltage measurements on +VE/-VE, SK2, SK3, SK4, and SK7.

Circuit Breakers and Fuses

F1 is a 4 Amp fast blow 250 VAC fuse that protects PS1's internal circuitry. This fuse does not blow if PS1's outputs are shorted or overloaded.

Troubleshooting

A short or overload on PS1's outputs causes them to drop. Look for obvious problems like shorted filter capacitors on other PCBs before replacing the supply. If PS1's outputs are simply out of spec and don't respond to the calibration procedures described below, replace the supply.

Removal and Replacement

Follow these steps to replace PS1:

***WARNING**: Dangerous AC line voltage is present on SK1.*

1. Disconnect AC power plug from facility's AC outlet.
2. Remove lower left-hand Workstation cover.
3. Loosen two quarter-turn fasteners that secure swing-out panel to lower left-hand side of chassis. Swing panel away from chassis.
4. Disconnect and tag wires from +VE, -VE, SK1, SK2, and SK3 terminals.
5. Remove four torx screws and lockwashers that secure PS1 assembly to chassis swing-out panel. Retain four screws and four lockwashers for reuse.
6. Inspect replacement power supply assembly for any obvious damage or missing components.
7. Mount replacement power supply assembly to chassis swing-out panel and secure mounting hardware.
8. Connect wires removed in step 4 to +VE, -VE, SK1, SK2, and SK3 terminals on replacement power supply. Secure all screws.
9. Connect AC power plug to facility's AC outlet.
10. Perform calibration procedure described below.
11. Check system for proper operation.
12. Close swing-out panel and secure quarter-turn fasteners.
13. Reinstall lower left Workstation cover.

Calibration

Calibration of the DC Power Supply PS1 consists of checking each output for proper voltage under load and making adjustments to the high-current +5 Volt output if necessary.

WARNING: *Dangerous AC voltages are present on connector SK1 of DC Power Supply PS1 during the following calibration procedure.*

CAUTION: *Be careful when making the following measurements. Short circuiting a DC output can cause burns and equipment damage.*

Note: *Make sure PS1 is fully installed with all loads connected before performing the following calibration procedure.*

Calibrate DC Power Supply PS1 as follows:

1. Remove left side Workstation cover.
2. Loosen two quarter-turn fasteners that secure swing-out panel to lower left-hand side of chassis. Swing panel away from chassis.
3. Make sure system's AC power plug is connected to facility's AC outlet.
4. Press Workstation ON/OFF pushbutton to turn on Workstation. Make sure pushbutton lights.
5. Check output of high current +5 Volt supply on +VE and -VE terminals. Output should measure +5.0 (±.25) VDC. If +5 Volt output is within range, go to step 7. If +5 Volt output needs adjustment, go to next step.

6. Adjust 5V O/P ADJ pot until output measures +5.0 (±.1) VDC. If PS1 cannot be adjusted to produce a satisfactory output under normal load conditions, replace PS1.
7. Check output of +12 Volt supply on SK2. Output should measure +12 (±1) VDC. This supply is not adjustable.
8. Check output of -12 Volt supply on SK2. Output should measure -12 (±1) VDC. This supply is also not adjustable.
9. Install left side Workstation cover.

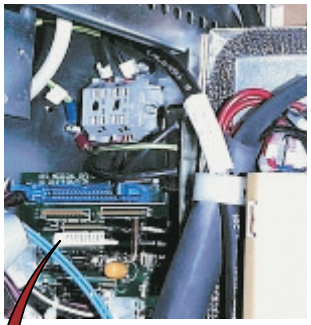
***Note**: If one or more DC outputs from PS1 do not meet specifications, replace PS1. If PS1 calibration is successful, disconnect the meter leads and perform the last three steps in the above Removal/Replacement procedure.*

DC Power Distribution PCB

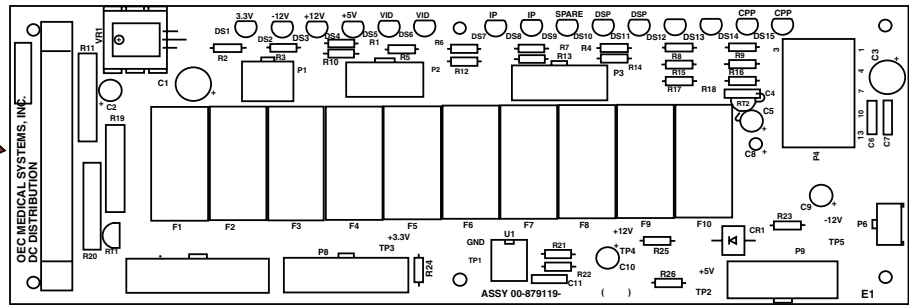
The DC Distribution PCB distributes DC power from PS1 to Workstation circuitry. The DC Distribution PCB is located inside the Workstation's Electronics Box near PS1.

Location

Remove the Workstation covers, loosen the two quarter-turn fasteners that secure PS1's swing-out mounting bracket, and swing out the bracket to gain access to the DC Distribution PCB.



View inside electronics box on left-hand side of workstation



DC Distribution PCB

Circuit Description

Refer to the following assembly drawing and to **DC Distribution PCB Schematic 00-879117** while reading the following description.

Overview

The DC Distribution PCB distributes DC potentials and the PWR_FAIL signal from PS1 to Workstation circuitry. The DC Distribution PCB also distributes voltage sense and and temperature signals from Workstation circuitry to the External Interface PCB.

Host CPU Reset

U1 supplies a reset signal to the Host CPU through P9 if the +5 Volt supply from PS1 drops below +4.65 Volts.

+3.3 Volt Supply

VR1 on the DC Distribution PCB generates a +3.3 Volt supply from +5 Volts, which P7 distributes to the Image Processor PCB and Video Controller PCB, and which P8 distributes to the Display Controller PCB and Cine Bridge PCB.

Status LEDs

There are 15 status LEDs on the DC Distribution PCB.

DS1 lights when VR1 is active and +3.3 Volts is present.

DS2 lights when -12 Volts from PS1 is present.

DS3 lights when +12 Volts from PS1 is present.

DS4 lights when +5 Volts from PS1 is present.

DS5 lights when the +5V_SEN signal from the Video Controller PCB is present.

DS6 lights when the +3.3V_SEN signal from the Video Controller PCB is present.

DS7 lights when the +5V_SEN signal from the Image Processor PCB is present.

DS8 lights when the +3.3V_SEN signal from the Image Processor PCB is present.

DS9 is not used.

DS10 lights when the +5V_SEN signal from the Display Controller PCB is present.

DS11 lights when the +3.3V_SEN signal from the Display Controller PCB is present.

DS12 lights when the +3.3V_SEN signal from the Cine Bridge PCB is present.

DS13 lights when the +5V_SEN signal from the Cine Bridge PCB is present

DS14 lights when the +5V_SEN signal from the Control Panel Processor PCB is present.

DS15 lights when the +12V_SEN signal from the Control Panel Processor is present.

Distribution Functions

The DC Distribution PCB's nine connectors distribute DC power, control signals, and status signals as follows:

P1 supplies +5 Volts and +12 Volts from PS1 to the Control Panel Processor. P1 also accepts +5 Volt and +12 Volt sense signals from the Control Panel Processor for distribution through P5 to the System Interface PCB.

P2 supplies +5 Volts and +12 Volts from PS1 to the Floppy Disk Drive.

P3 supplies +5 Volts and +12 Volts from PS1 to the Cine 2 Disk Backplane and to the Hard Disk Drive.

P4 distributes +5 Volts, +12 Volts, and -12 Volts from PS1 to Workstation circuitry. It also transfers the PWR_FAIL signal from PS1 through P5 to the System Interface PCB. The +3.3 Volt input to PS1 on P4-9 is not used.

P5 provides +5 Volts and +12 Volts from PS1 to the System Interface PCB. P5 also supplies the System Interface PCB with the PWR_FAIL signal from PS1, and with temperature and voltage sense signals from other Workstation circuitry.

P6 accepts +12 Volt sense, +5 Volt sense, and temperature signals from the Cine 4-Disk Backplane and distributes these signals through P5 to the System Interface PCB.

P7 supplies +5 Volts and +3.3 Volts to the Video Controller and Image Processor. PS1 generates the +5 Volts, and VR1 generates the +3.3 Volts. P7 also accepts +3.3 Volt and +5 Volt sense signals, transferring them through P5 to the System Interface PCB.

P8 supplies +5 Volts and +3.3 Volts to the Display Controller and Cine Bridge assembly. P8 also accepts +3.3 Volt and +5 Volt sense signals, transferring them through P5 to the System Interface PCB.

P9 supplies +5 Volts, +12 Volts and -12 Volts to the Host CPU, and +12 Volts to the Host CPU's DC fan. U1 on the DC Distribution PCB sends the reset signal *SYSRST through P9-8 to the Host CPU when the +5 Volt supply falls below +4.65 Volts.

Test Points

There are five test points on the DC Distribution PCB.

TP1 is chassis ground.

TP2 is +5 Volts.

TP3 is +3.3 Volts.

TP4 is +12 Volts.

TP5 is -12Volts.

Circuit Breakers and Fuses

There are ten fuses on the DC Distribution PCB.

F1 is a 6.3 Amp, 250 Volt fuse that protects +5 Volts to the System Interface PCB and Cine Bridge assembly.

F2 is a 10 Amp, 250 Volt fuse that protects +5 Volts to the Video Controller and Image Processor.

F3 is a 1 Amp, 250 Volt fuse that protects +12 Volts to the Control Panel Processor, the Cine 4 Disk Backplane, and System Interface PCB.

F4 is a 5 Amp, 250 Volt fuse that protects +12 Volts to the Floppy Disk Drive and Magneto Optical Drive.

F5 is a 5 Amp, 250 Volt fuse that protects +5 Volts to the Floppy Disk Drive and Magneto Optical Drive.

F6 is a 3.15 Amp, 250 Volt fuse that protects +5 Volts to the Control Panel Processor.

F7 is a 5 Amp, 250 Volt fuse that protects +12 Volts to the Hard Disk Drive and Cine 2 Disk Backplane.

F8 is a 5 Amp, 250 Volt fuse that protects +5 Volts to the Hard Disk Drive and Cine 2 Disk Backplane.

F9 is a 10 Amp, 250 Volt fuse that protects +5 Volts to the Host CPU.

F10 is a 5 Amp, 250 Volt fuse that protects +12 Volts to the Host CPU and Host CPU fan.

Troubleshooting

Since most of the DC Distribution PCB circuitry is passive, the most likely failure is a fuse. If U1 fails, the Host CPU may spontaneously reboot or lock up. If VR1 fails, the Video Controller, Image Processor, Display Controller, or Cine Bridge PCBs may also fail.

Removal and Replacement

1. Disconnect AC power plug from facility's AC outlet.
2. Remove Workstation covers.
3. Loosen two quarter-turn fasteners that secure swing-out PS1 bracket to lower left-hand side of Workstation chassis.
4. Swing out PS1 bracket to gain access to DC Distribution PCB.
5. Remove six torx screws and lockwashers that secure DC Distribution PCB to Electronics Box. Retain six screws and four lockwashers for reuse.
6. Disconnect and tag connectors from P1 through P9.
7. Inspect replacement DC Distribution PCB for any obvious damage or missing components.
8. Reinstall connectors on P1 through P9 on replacement DC Distribution PCB.
9. Mount replacement DC Distribution PCB in Electronics Box using hardware removed in step 5. Secure hardware.
10. Connect AC power plug to facility's AC outlet.
11. Check system for proper operation.
12. Close swing-out power supply bracket loosened in step 3 and secure quarter-turn fasteners.
13. Reinstall Workstation covers.

Calibration

No adjustments are necessary after replacing the DC Distribution PCB.

Cine Disk Power Supply PS2

PS2 is part of the optional Cine 4-Disk Assembly, and supplies +5 VDC and +12 VDC to the Cine 4-Disk Backplane. It is identical to PS1, except that PS2's -12 Volt output is not used.

Please refer to **DC POWER SUPPLY PS1** for technical information that is applicable to PS2.

Section 4 - Host Controller

The following paragraphs describe the components in the Workstation's Host Controller subsystem. The information is organized as follows:

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Please refer to **Workstation Interconnect Diagram 00-878981** as you read the following sections.

Host Controller

The Host Controller provides primary control of the entire imaging system. It interfaces with every major subsystem in the Workstation, and communicates with intelligent devices in the generator through the ArcNet controller on the **System Interface PCB**.

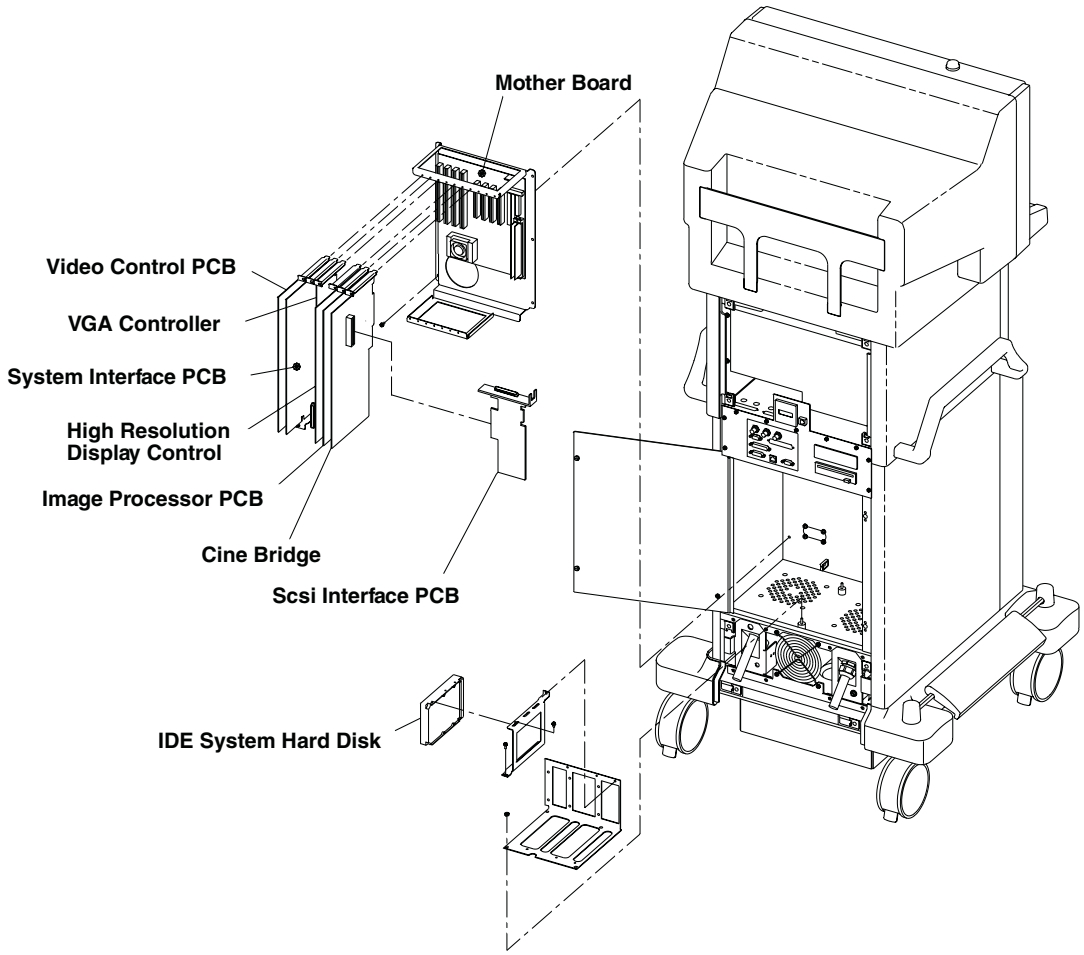
Physical Configurations

The following illustrations show the two versions of the Host Controller hardware.

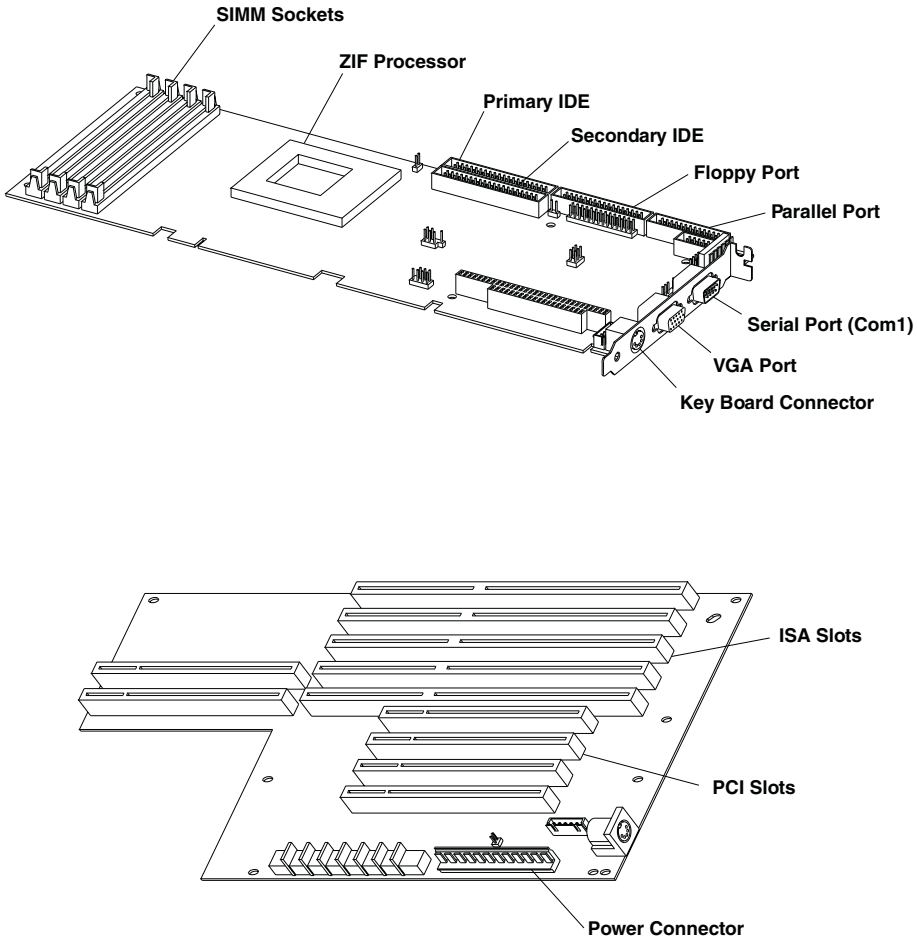
Page 4-5 shows an early Host Controller, which consists of a standard Socket 7 motherboard equipped with appropriate peripherals mounted in the Workstation's Electronics Enclosure.

The illustration on **page 4-6** shows upgraded components in the current version of the Host CPU. This current version uses a **Passive Backplane** equipped with a **Single Board Computer** and appropriate peripherals.

Despite their many physical differences, earlier and current Host CPU systems work similarly and perform the same functions. Both systems mount in the Workstation's Electronics Box. The current configuration is easier to troubleshoot and maintain because the Single Board Computer is far easier to access and replace.



Exploded View of Workstation (Earlier Version)



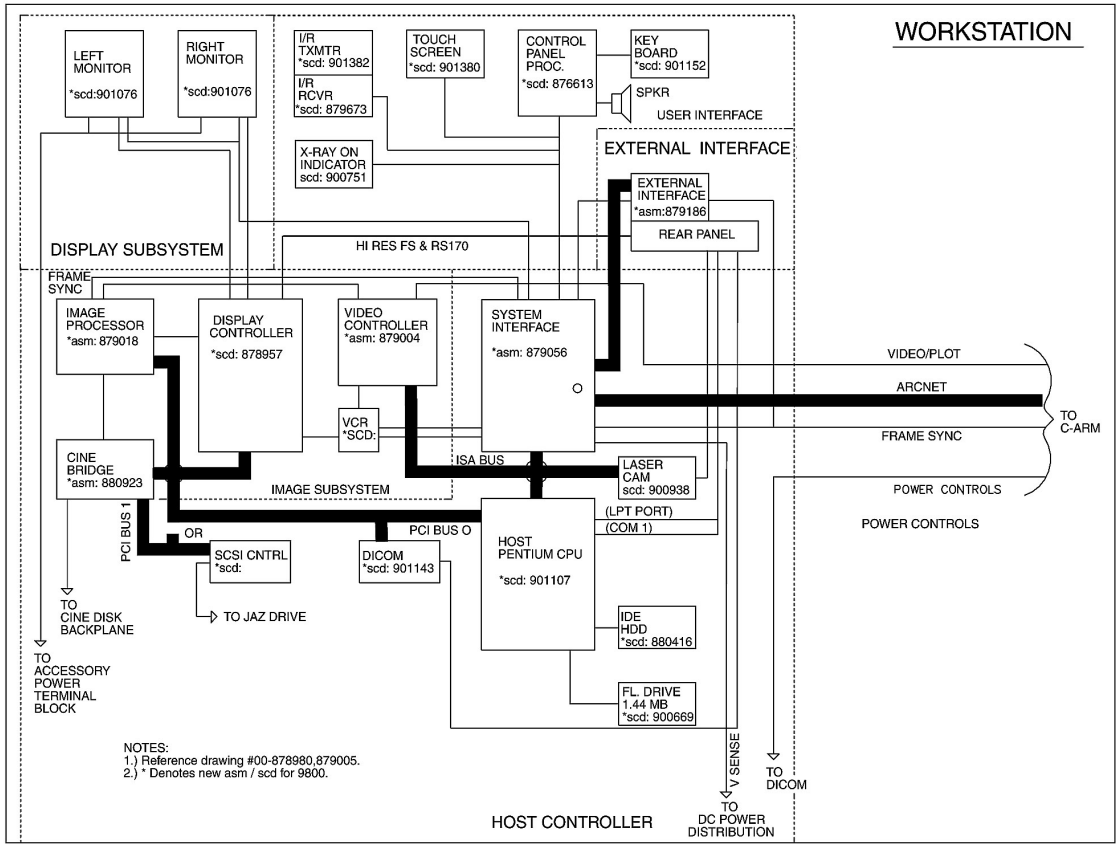
Single Board Computer and Passive Backplane

Functional Description

The following block diagram shows how the Host Controller interfaces with the rest of the system. The Host Pentium CPU block in the diagram refers to the Pentium motherboard in earlier systems and to the Single Board Computer/Passive Backplane combination in current systems.

The Host Pentium CPU executes program code it loads at bootup. The code loads from the IDE Hard Disk Drive, but can also load from the Floppy Disk Drive if a bootable disk is mounted in this drive when the operator turns the Workstation on. The Laser Camera Interface, System Interface, and Video Controller reside on the Host CPU's 16-bit ISA bus and communicate with other system devices over dedicated lines. The Display Controller, Image Processor, DICOM controller, and Cine Bridge reside on the 32-bit PCI 0 bus and communicate over dedicated lines as shown on the diagram. The Cine Bridge generates PCI bus 1, which communicates with the SCSI controller. The SCSI controller is currently dedicated to the "Removable Dynamic Digital Disk", which is commonly called the Jaz drive.

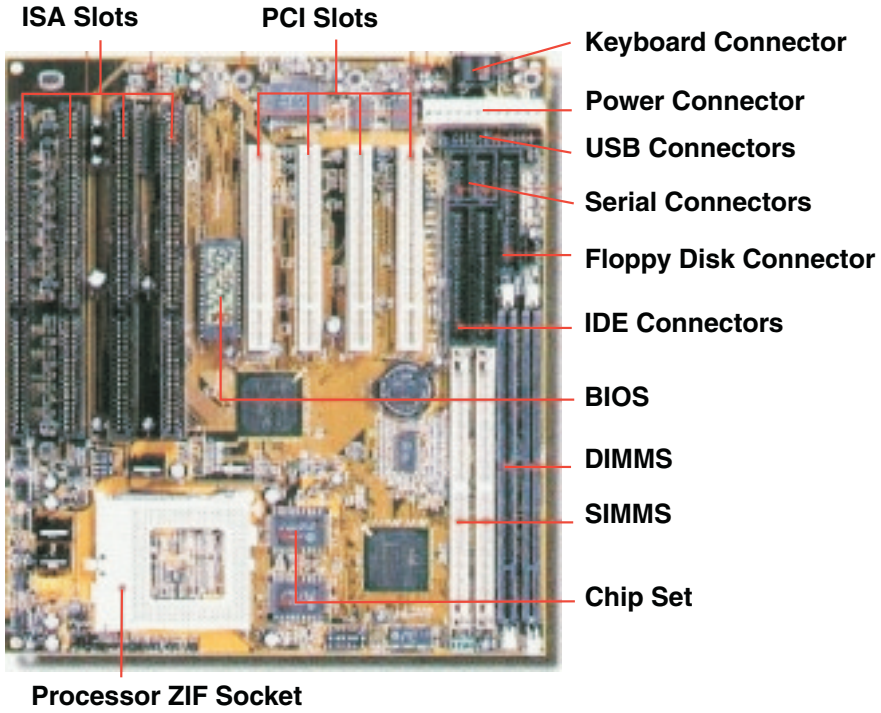
The System Interface PCB generates the ARCNet, the principal communication path between the Host CPU and intelligent devices.



Host CPU Block Diagram

Host Pentium CPU Motherboard

The following paragraphs describe the Host Pentium CPU motherboard, which serves as the Host Controller in earlier OEC Workstations.



Host Pentium CPU Motherboard

Description

The Host Pentium CPU motherboard is a standard Socket 7 motherboard. It is a four-layer PCB with the Baby AT form factor size of 22 cm by 25 cm (8.7” x 9.8”). It has the following features:

Processor: Single ZIF socket 7 with Pentium 233 MHz processor.

Chipset: Intel 430TX (82439TX, 82371AB)

Expansion Slots: Four 32-bit PCI slots. Four 16-bit ISA slots.

Cache: 512K.

Memory: Provides two 72-pin SIMM Sockets and two 168-pin DIMM SDRAM (or RAM) sockets. Equipped with 4 Mb of SDRAM.

On-Board IDE: IDE connector to support IDE hard drive.

On-Board I/O: Two serial ports, one parallel port, one floppy disk connector, one PS/2 mouse cable connector.

BIOS: Flash ROM with power management, and Plug and Play capabilities.

Location

The Host Pentium CPU motherboard resides in the Workstation’s Electronics Box as shown on **page 4-5**.

Circuit Description

The Host Pentium CPU Motherboard is a purchased part, and no schematic is available.

Test Points

None available for servicing purposes.

Circuit Breakers and Fuses

None.

Troubleshooting

The best way to check the Host CPU for proper operation is to watch for CMOS or memory errors on the Service Monitor while the system boots up.

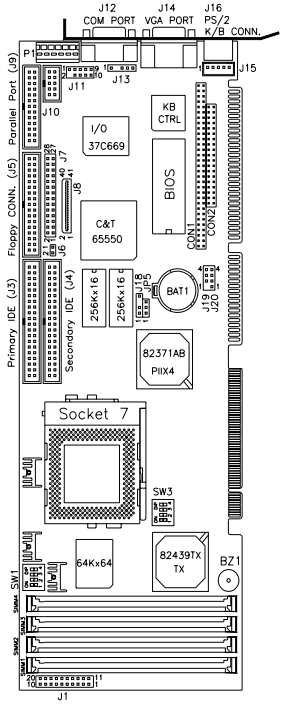
Removal and Replacement

If the Host Pentium CPU motherboard fails, you must remove it and upgrade the system by installing the Passive Backplane PCB and Single Board Computer. Follow these steps:

1. Disconnect Workstation's power plug from AC outlet.
2. Remove Workstation's Rear Cover.
3. Loosen screws that secure cover to Workstation's Electronics Box, and open cover.
4. Carefully remove all printed circuit boards that plug into Host Pentium CPU motherboard. Tag all wiring that you might have trouble reconnecting later. Store each removed PCB in an antistatic bag to avoid damage from electrostatic discharge.
5. Disconnect and tag all power and I/O connectors that mate with motherboard.
6. Remove torx panhead screws that secure motherboard to chassis.
7. Remove motherboard from Workstation.
8. Install Passive Backplane in Workstation chassis. Secure Passive Backplane using torx screws you removed in step 6.
9. Install all connectors you removed in step 5 that must connect to the Passive Backplane. In most cases, this will be just the power supply connectors. Be careful to observe proper polarity and alignment of each connector.
10. Carefully reinstall each PCB you removed in step 4. Be careful to properly reinstall all wiring.
11. Connect Workstation's power plug to active AC outlet.
12. Power up system and check for proper operation.
13. Close cover to Workstation's Electronics Box. Secure captive fasteners you loosened in step 3.
14. Install Workstation's rear cover.

Single Board Computer

The following paragraphs describe the Single Board Computer PCB, which along with the Passive Backplane serves as the Host Controller in the current OEC Workstation.



Single Board Computer

Description

The Single Board Computer (SBC) is a PCI Pentium CPU board that is designed for use with a Passive Backplane. This arrangement does much to enhance system serviceability. The SBC features a ZIF Socket 7 design. The microprocessor currently in use is the 233 MHz Pentium MMX.

The Single Board Computer has an on-board temperature sensor that sounds the audible alarm (BZ1) when the microprocessor temperature exceeds a safe heat level. BIOS power management functions slow down the CPU clock, turn off the monitor screen and system fan, and stop the hard disk drive spindle from turning during prolonged idle periods.

The Single Board Computer has these features:

Processor: 233 MHz Pentium MMX.

Chipset: Intel 430TX PCIset with built-in PCI EIDE

Expansion Slots: None. Single Board Computer must be used with Passive Backplane, described below.

Cache: 512K.

Memory: Provides two 72-pin SIMM Sockets and two 168-pin DIMM SDRAM (or DRAM) sockets. Equipped with 4 Mb of SDRAM.

On-Board IDE: Has Primary and Secondary IDE connector.

On-Board I/O: Two serial ports, one parallel port, one floppy disk connector, one PS/2 mouse cable connector.

BIOS: Flash ROM with power management, and Plug and Play capabilities.

VGA Display: C&T 65550 VGA chip on board.

Location

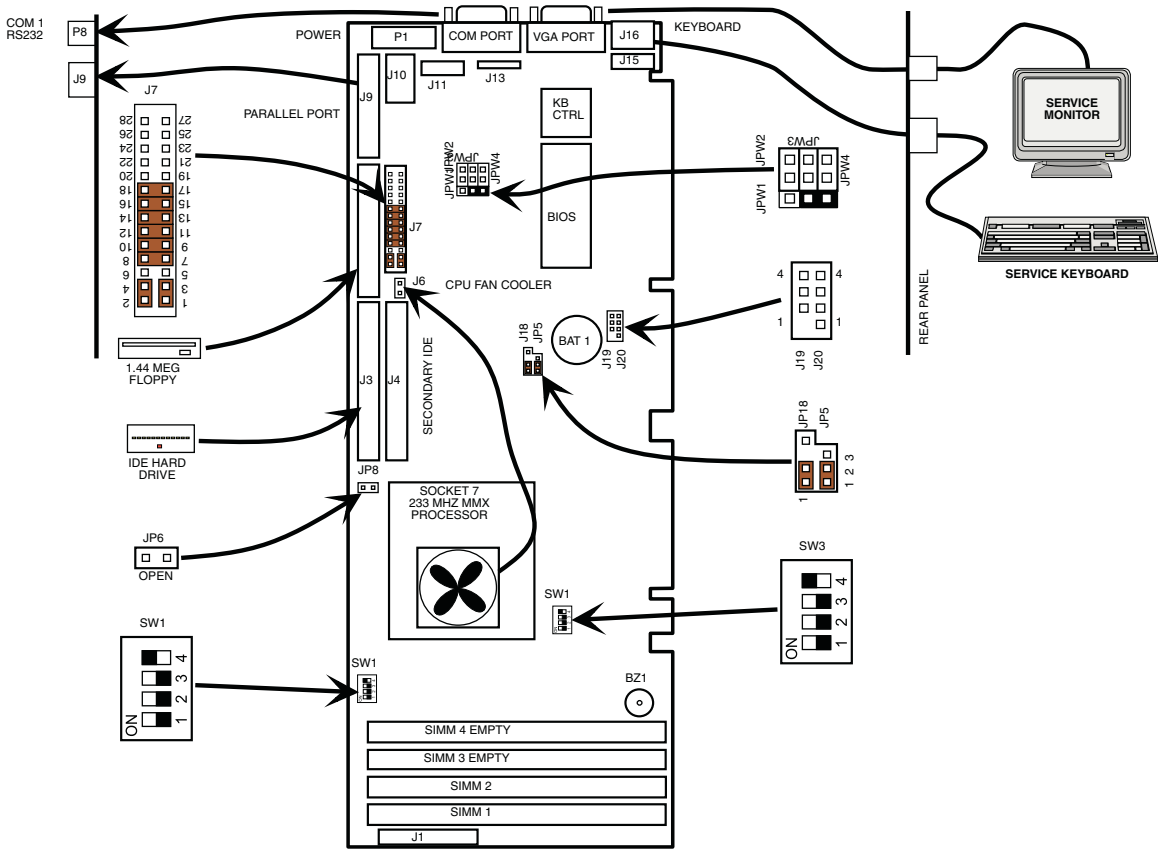
The Single Board Computer mounts in PCI/ISA Slot 1 on the Passive Backplane PCB, which is described in the following paragraphs.

Circuit Description

The Single Board Computer is a purchased part, and no schematic or detailed circuit description is available.

The following paragraphs describe the switches, jumpers, and connectors you must deal with when you upgrade to or replace a Single Board Computer.

Please refer to the illustration shown on the following page to identify individual components.



Single Board Computer Components

The following paragraphs describe switches, connectors, and jumpers on the Single Board Computer PCB. The descriptions appear in clockwise order starting with J1 at the bottom of the board.

J1 - Front Panel Bezel Connector

This connector is not used in the OEC Workstation. Normally it would interface with a reset button, hard disk activity LED, turbo LED, speaker, and other devices on the front panel bezel of a personal computer case.

SIMM Sockets

These sockets hold up to 256 Mb of FPM/EDO DRAM. Presently only SIMM1 and SIMM2 are populated with a 32 Mb SIMM in each socket.

SW1 and SW3 - CPU Frequency Selectors

To configure these switches for the 233 MHz Pentium MMX CPU, set all switches to OFF except for SW1-4.

JP6 - Use Unknown

The use or function of this jumper is not detailed in vendor data. Leave it open.

J3, J4 - IDE Connectors

J3 is the 40-pin Primary IDE connector for the system Hard Disk drive, which resides in the Electronics Box as shown on **page 4-5** of this section. When connecting the Hard drive's flat ribbon cable to the Single Board Computer, orient the tracer on the flat ribbon cable to the pin 1 end of J3. J4, the Secondary IDE connector, is not currently used.

J5 - Floppy Drive Connector

J5 is the 34-pin connector for the Floppy Disk drive, which mounts at the rear of the Workstation, as shown on **page 4-54** of this section. When connecting the Floppy drive's flat ribbon cable to the Single Board Computer, orient the tracer on the flat ribbon cable to the pin 1 end of J5.

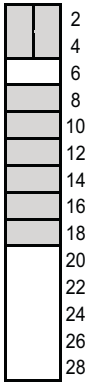
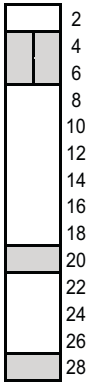
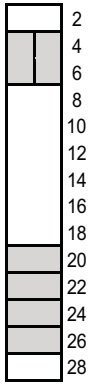
J6 - Microprocessor Fan Power

This connector supplies +12 Volts DC to the cooling fan mounted on the Pentium CPU. Pin 1 of this connector is positive.

J7 - COM2 Port Configuration Jumpers

Jumpers on J7 determine the configuration of Com Port 2, which is located on J10 of the Single Board Computer. Unlike COM1, which is fixed for RS-232 use only, COM2 is selectable for RS-232, RS-422, or RS-485. Since COM2 is not currently used, it really doesn't make much difference how these jumpers are installed.

The following table shows how to install jumpers to configure COM2. The table is included for future reference.

COM 2			
JUMPER SETTING (PIN CLOSED)	1-3 2-4 7-8 9-10 11-12 13-14 15-16 17-18	3-5 4-6 19-20 27-28	3-5 4-6 19-20 21-22 23-24 25-26
			
	J7	J7	J7

COM2 Port Configuration Jumpers

J9 - Parallel Port Connector

J9 on the Single Board Computer connects to J9 on the Workstation's rear panel. This port serves as the interface for the optional Film/Paper Printer, but it can be used for other devices.

J10 - COM2 Serial Port

J10 is a muti-purpose serial port that is configured by jumper placement on J7. You can set this port up to function as an RS-232, RS-422, or RS-485 interface. J2 is not currently used in the OEC Workstation.

P1 - Power Connector

This connector is not used. The Single Board Computer gets its power from the Passive Backplane PCB.

J12 - COM1 Serial Port

This connector cables to P8 on the Workstation's rear panel.

J13 - IrDA Connector

This connector handles wireless infrared communication with a keyboard or a mouse. It is not used on the OEC Workstation.

J14 - Service Monitor VGA Connector

This connector cables to the Workstation's rear panel VGA connector. You will typically use this connector to drive the Workstation's VGA service monitor.

J15 - External Keyboard Connector

This connector is not used. The Workstation's service keyboard and operator keyboard both use different circuitry.

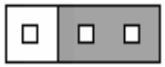
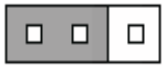
J16 - Service Keyboard Connector

This connector cables to the keyboard connector on the Workstation's rear panel, and supports the Service Keyboard.

JP5 - Clear CMOS Contents

CAUTION: *Contact the factory before resetting CMOS contents.*

Momentarily reposition this jumper to short pins 2 and 3 to reset CMOS contents on the Single Board Computer. This is a last resort when you cannot use setup to correct CMOS errors.

JP5	SETTING	FUNCTION
	Pin 2-3 short/closed	Clear CMOS content
	Pin 1-2 short/closed	Normal Operation

Clear CMOS Jumper

JPW1 Through JPW4 - Use Unknown

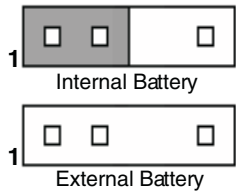
The use or function of these jumpers is not detailed in vendor data. **A single jumper must be installed as shown on page 4-16**.

J19, J20 - USB Connectors

These two jacks connect to the high-speed Universal Serial Bus on the Single Board Computer. These ports are not used in the OEC Workstation.

J18 - Battery Connectors and Jumpers

The 4-pin connector shown next allows you to connect an external battery to the Single Board Computer to maintain the information stored in the CMOS RAM when the built-in coin cell battery becomes weak.



J18 PIN#	SIGNAL NAME
1	GROUND
2	BATTERY GND
3	N.C.
4	VCC

External Battery Connector

Test Points

There are no accessible test points on the Single Board Computer. An extender card is not supplied.

Circuit Breakers and Fuses

There are no circuit breakers and fuses on the Single Board Computer.

Troubleshooting

The best way to check the Host CPU for proper operation is to watch for CMOS or memory errors on the service monitor while the system boots up.

Removal and Replacement

The following paragraphs describe how to replace the Single Board Computer.

1. Turn off power to Workstation.
2. Remove Workstation's Rear Cover.
3. Loosen screws that secure cover to Workstation's Electronics Box, and open cover.
4. Remove the 6-32, ½" Torx screw and Retainer Board that secure Single Board Computer to Passive Backplane.
5. Remove the 6-32, 3/8" Torx screw.
6. Carefully withdraw Single Board Computer from Electronics Box.
7. Disconnect all ribbon and power cables from Single Board Computer. Tag all wiring you might have trouble installing later.
8. Connect wiring you removed in step 7 to replacement Single Board Computer.
9. Install Single Board Computer into Passive Backplane.
10. Reinstall and secure mounting hardware you removed in steps 4 and 5.
11. Turn on Workstation and check system for proper operation.
12. Close and secure cover to Workstation's Electronics box.
13. Install Workstation's Rear Cover.

Passive Backplane

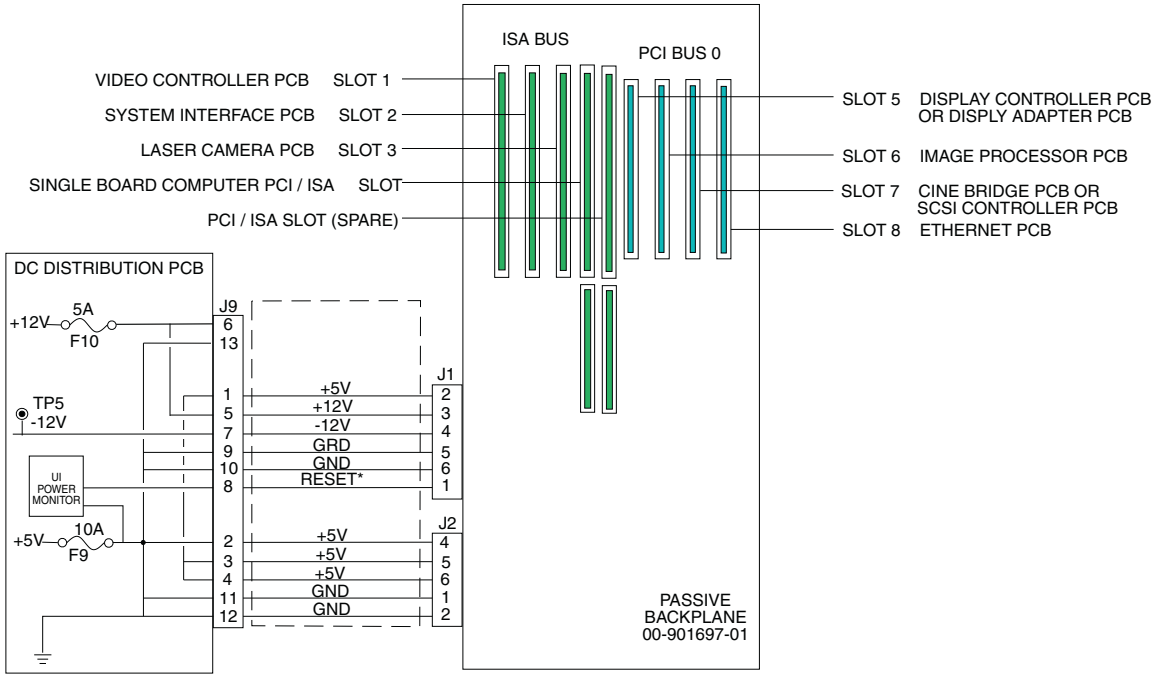
The Passive Backplane shown on **page 4-6** provides bus slots for all Host CPU ISA and PCI PCBs that mount in the Electronics Box. It also conducts DC power from the DC Distribution PCB to these boards. It has two PCI/ISA slots, one of which serves as the mounting point for the Single Board Computer. The other PCI/ISA slot on the Passive Backplane is empty.

Location

The Passive Backplane resides at the rear of the Electronics Box, and serves as the motherboard for circuit boards that reside in the box.

Circuit Description

There is no active circuitry on the Passive Backplace. It simply routes power and bus signals as shown in the following block diagram.



Passive Backplane Functional Diagram

Test Points

There are no test points on the Passive Backplane.

Circuit Breakers and Fuses

There are no circuit breakers or fuses on the Passive Backplane.

Troubleshooting

Mechanical or thermal damage are the most likely causes of trouble on the Passive Backplane. A damaged edge connector on a card slot is the most likely scenario. You should not attempt to repair a damaged edge connector in the field. Instead, replace the Passive Backplane following the procedure outlined below.

If any PCB plugged into the Passive Backplane gives a failure indication, try to re-seat the PCB first. If that does not fix the problem, replace the offending PCB. If the problem persists, carefully inspect the Passive Backplane PCB and connectors for signs of damage. If the problem persists, replace the Passive Backplane.

Removal and Replacement

Follow these steps to replace the Passive Backplane.

1. Turn off power to Workstation.
2. Remove Workstation's Rear Cover.
3. Loosen screws that secure cover to Workstation's Electronics Box, and open cover.
4. Carefully remove each PCB that plugs into the Passive Backplane. Tag all wires you might have trouble reconnecting later.
5. Disconnect the power cables from to J1 and J2 on the Passive Backplane.
6. Remove all nine 6-32, ½" torx screws and corresponding #6 lockwashers that secure Passive Backplane to chassis.
7. Lift Passive Backplane from chassis.
8. Install replacement Passive Backplane to chassis using hardware you removed in step #4.

CAUTION: *Be careful when installing the power cables in the next step. The black wires on P1 MUST be adjacent to the black wires on P2. If the black wires in each plug are not next to each other, the power plugs are installed BACKWARDS. Powering up the Workstation in this condition can cause extensive damage.*

9. Connect power cables you removed in step #5.
10. Carefully install each PCB you removed in step #4. Reconnect appropriate wires to each PCB.

System Interface PCB

Please refer to **Workstation Interconnect Diagram 00-878981** while reading the following paragraphs. The circuitry described appears in **System Interface PCB Schematic Diagram 00-879054**.

Description

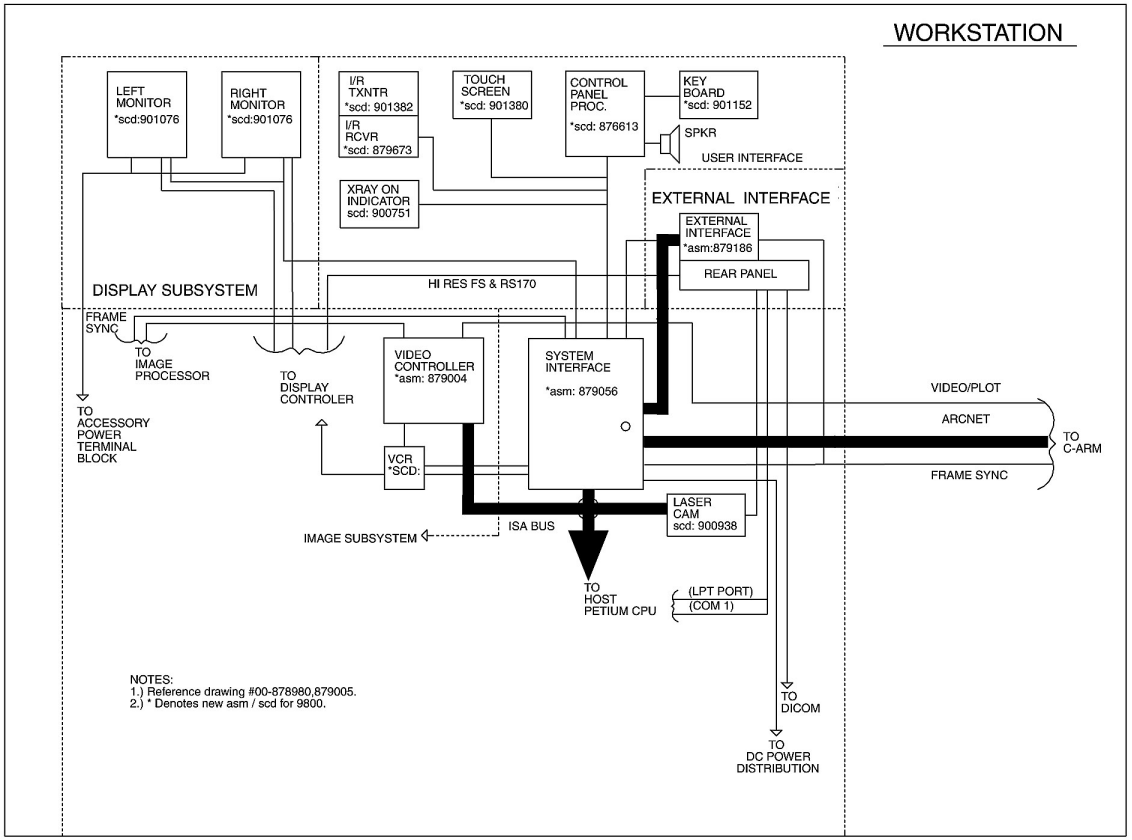
The System Interface PCB is an interface between the Host Controller and peripheral devices. The Host Controller addresses 16 different registers on the System Interface PCB to communicate with the external VCR, access the system ARCNet network, provide real time control of the High Resolution Monitors, and access the Option PROM. In addition, through communication with the System Interface PCB, the Host Controller can monitor a number of Workstation PCB voltages, monitor the temperature at several locations within the Workstation, and control several external devices such as X-ray warning lights and an automatic Dye Injector.

Location

The System Interface PCB connects to the ISA Bus slot 2 on the Host Pentium CPU Motherboard or Passive Backplane.

Circuit Description

The following block diagram shows how the System Interface PCB communicates with other devices in the Workstation.



System Interface Communications

ISA Bus Interface. These connections are the communication path between the Host Controller and the System Interface PCB

RS-232 Ports. The System Interface PCB provides five RS-232 ports. Three of these five serial ports communicate directly over three dedicated UART channels, while the other two serial ports communicate in a multiplexed fashion over a fourth UART channel. The RS-232 channels are assigned as follows:

Port 1: Control Panel Processor

Port 2: Spare (future use)

Port 3: Right Monitor

Port 4: Left Monitor

Port 5: Touch Screen Interface

ARCNet Nodes. The System Interface PCB provides two independent ARCNet nodes. The first node is the 9800 ArcNet Host that communicates with other system ARCNet devices such as those in the generator, and with any external user ARCNet devices that may be attached to the Workstation's rear panel. The second node functions as a Diagnostics gateway that provides a data pathway between the system ARCNet and an RS-232 interface for a laptop computer.

Analog to Digital Inputs. The System Interface PCB has 24 analog-to-digital inputs that each have a 10-bit resolution. These inputs monitor Workstation power supply voltages, two Workstation temperatures, and the room brightness level.

Option PROM. This 32K (8-bit word) device configures the Host Controller's BIOS for operation in the Workstation.

Address and Data Buffers. These devices buffer data between the Host Controller and the System Interface PCB.

Software-Controlled Relay Drive Signals. These signals control relays on the **External Interface PCB** that drive such things as X-Ray On lights, Room in Use lights, contrast injection devices, etc.

Software-Controlled Monitoring. UARTs on the System Interface PCB monitor external conditions such as Left and Right Monitor on, door interlock status, etc. These inputs are protected against transients, surges, etc.

Diagnostic Code Display. The System Interface PCB has two alphanumeric displays for Host Controller diagnostic hexadecimal codes. These displays mount on the front edge of the board so they are easily viewable during system operation.

Parallel VCR Interface. This interface allows the Host Controller to run the optional VCR under program control. The parallel port provides discrete lines for such functions as stop, play, pause, record, etc.

Test Points

There are no test points on the System Interface PCB that can be used to troubleshoot problems.

Circuit Breakers and Fuses

There are no circuit breakers or fuses on the System Interface PCB.

Troubleshooting

The following paragraphs provide a brief description of several possible System Interface PCB failures:

- A failure of decoder U57 prevents the Host Controller from communicating with Workstation peripherals.
- A failure of the ARCNet Controller U37 prevents the Host Controller from communicating with any devices on the internal or external ARCNet.
- A failure of the Quad UART U34 disrupts serial communications between the Host Controller and the High Resolution Monitors, Control Panel Processor, Optional VCR, and any peripheral device connected to the serial port at the rear panel of the Workstation.

Any of the above failures requires replacement of the System Interface PCB.

Removal and Replacement

Replacement of the System Interface PCB is a simple process. Follow these steps:

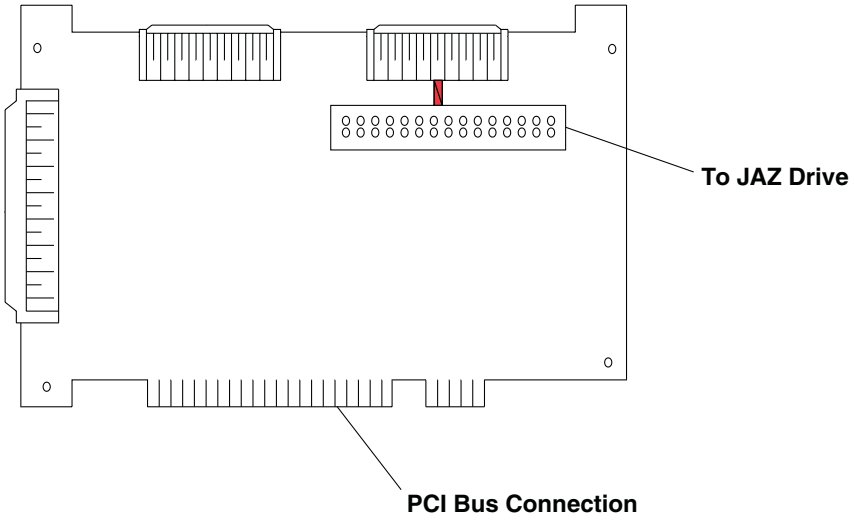
1. Turn off Workstation and disconnect its AC line from electrical outlet.
2. Remove Workstation's Rear Cover.
3. Loosen captive fasteners that secure hinged cover on Electronics Box. Open cover.
4. Identify the System Interface PCB, which occupies ISA Slot 2 in the Host Pentium CPU Motherboard or Passive Backplane.
5. Remove two 6-32 x 3/8" screws that secure System Interface PCB to card rack.
6. Gently pull board forward to release it from the motherboard or backplane. Pull board just far enough to get access to attached cables.
7. Disconnect seven cables from board. Tag cables so you can readily identify where to plug them into replacement board.
8. Place removed System Interface PCB in antistatic bag to prevent ESD damage.
9. Connect cables you removed in step 7 to replacement System Interface PCB.
10. Align edge connectors on replacement board with ISA Slot 2 in motherboard or backplane. Gently push board into place.
11. Connect Workstation to AC line and check system for proper operation.
12. Close cover on Electronics Box and secure cover with captive fasteners.
13. Install Workstation's Rear Cover.

SCSI Controller PCB

The following paragraphs describe the SCSI controller, which serves as an interface between the Host Controller and the optional Jaz drive. The card can support several SCSI devices, although it does not presently do so.

Description

The SCSI Controller PCB enables Ultra SCSI devices to communicate with the Host Controller over the 32-bit PCI local bus.

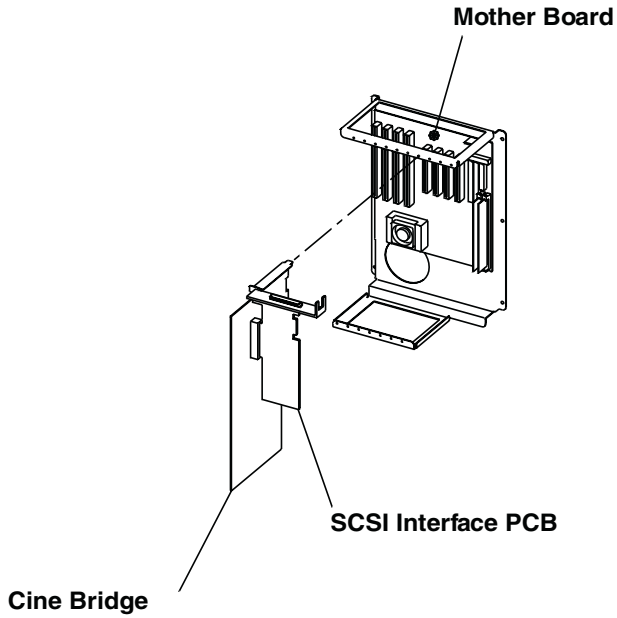


SCSI Controller PCB

Location

The SCSI Controller connects to the PCI bus in slot 7 on the Host Pentium CPU Motherboard or Passive Backplane.

Workstations equipped with the Cine Disk are configured differently with the SCSI Controller mounting in a PCI slot on the Cine Bridge PCB, which mounts in slot 7 of the Host Pentium CPU Motherboard or Passive Backplane. The following illustration shows this arrangement.



SCSI Controller PCB Mounted to Cine Bridge PCB

Circuit Description

The SCSI Controller is a commercially purchased assembly that the manufacturer furnishes to OEC without schematic or circuit description.

Test Points

No test points are available on the SCSI Controller PCB.

Circuit Breakers and Fuses

There are no circuit breakers or fuses on the SCSI Controller PCB.

Troubleshooting

The first indication of failed SCSI Controller PCB is an inoperative Jaz drive. If this happens, first use RUT to make sure the drive is properly activated. Next, physically check the drive to make sure the data and power cables are properly connected. If you've still got a dead drive, replace the SCSI Controller PCB.

Removal and Replacement

Follow these steps to replace the SCSI Controller PCB.

1. Turn off Workstation and disconnect it from AC power outlet.
2. Remove Workstation's Rear Cover.
3. Loosen captive fasteners that secure Electronics Box cover. Open cover.
4. Remove 6/32-3/8-inch screw that secures SCSI Controller PCB.
5. Remove SCSI Controller PCB from Cine Bridge PCB, Host Pentium CPU Motherboard, or Passive Backplane. Disconnect Jaz drive data cable from SCSI Controller PCB.
6. Place removed SCSI Controller PCB in antistatic bag to prevent ESD damage.
7. Connect Jaz drive data cable to replacement SCSI Controller PCB.
8. Install replacement SCSI Controller PCB in appropriate PCI slot. Secure card with screw you removed in step 4.
9. Apply power to Workstation and check for proper Jaz drive operation.
10. Close and secure Electronics Box cover.
11. Install Workstation's Rear Cover.

System IDE Hard Disk Drive

The following paragraphs describe the Workstation's hard disk drive.

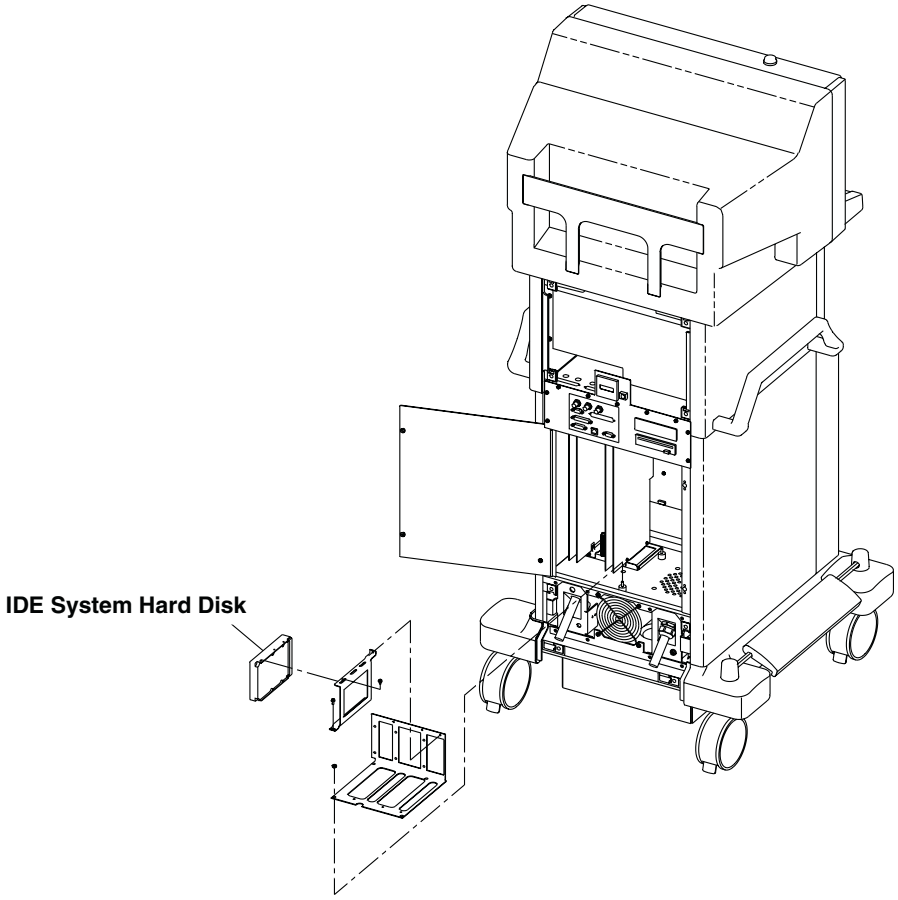
Description

The Workstation's hard disk drive is a standard EIDE device. It has a standard 40-pin EIDE connector and an Ultra ATA interface. It exchanges data directly with the Host Pentium CPU Motherboard or Single Board Computer. It receives DC power directly from the **DC Distribution PCB**.

The Workstation normally boots from the 50-megabyte non-DOS partition of the hard drive, which ships from OEC with the Nucleus® operating system and OEC application software installed.

Location

The hard disk drive mounts in the bottom right-hand corner of the Electronics Box as shown in the following illustration.



Hard Disk Drive Location and Mounting Details

Circuit Description

The manufacturer supplies the hard disk drive with no schematic or circuit details.

Test Points

None available.

Circuit Breakers and Fuses

There are no user accessible fuses or circuit breakers on the hard disk.

Troubleshooting

If the system won't boot up properly, connect the Service Monitor to the VGA connector on the Workstation's rear panel. Then connect the Service Monitor's AC line plug to a convenient outlet. Turn on the Service Monitor and reboot the system. Watch the messages for indications of hard disk failure. If such messages appear, or if the system simply refuses to boot, replace the hard drive.

Removal and Replacement

***Note**: Be sure you're replacing the System IDE Hard Disk and not one of the Cine Disks in the following procedure.*

Follow these steps to replace the hard disk drive:

1. Turn off Workstation and remove its AC power plug from AC outlet.
2. Remove Workstation's Rear Panel.
3. Loosen captive screws that secure Electronics Box cover. Open cover.
4. Loosen screws that secure hard disk drive to its mounting brackets.
5. Carefully pull drive forward to gain access to power and data cable connected to rear of drive. Disconnect both cables from drive.
6. Remove drive from Workstation.
7. Determine how MASTER/SLAVE jumper is installed at rear of removed drive.
8. Set MASTER/SLAVE jumper on replacement drive to match jumper position on original drive.
9. Place original drive in antistatic bag to protect it from ESD.
10. Connect power cable and data cable to replacement drive.
11. Mount replacement drive in Electronics Box. Install and secure mounting screws you removed in step #4.
12. Apply power to Workstation and check for proper hard disk operation.
13. Close and secure Electronics Box cover.
14. Install Workstation's Rear Cover.

3.5-inch Floppy Disk Drive

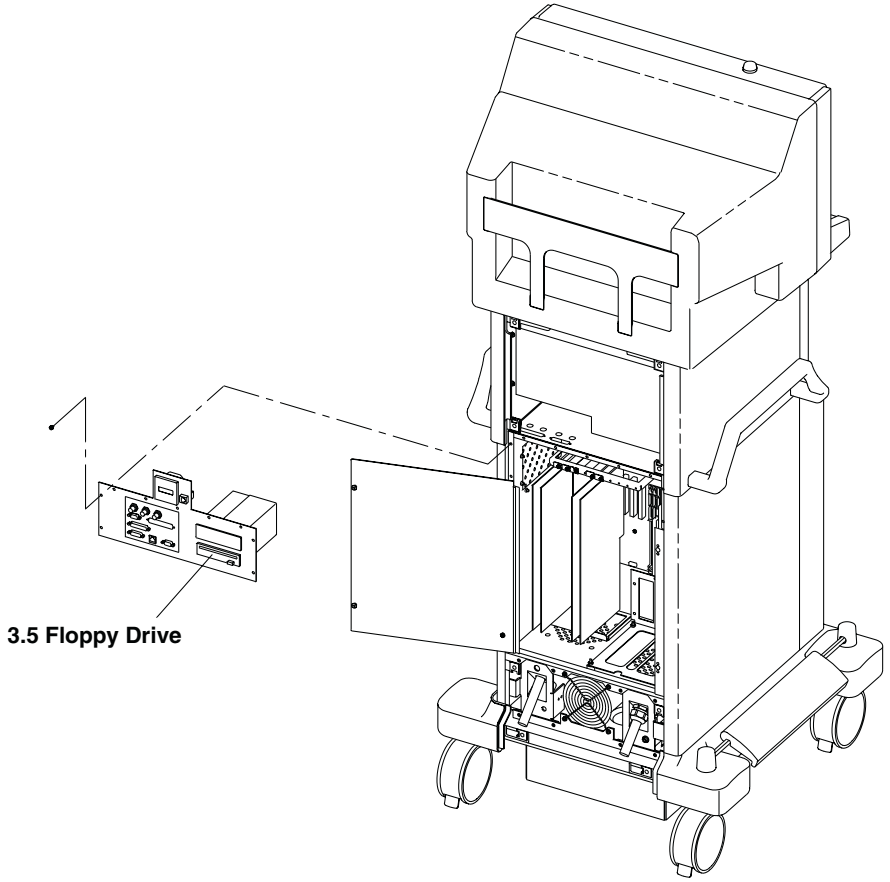
The floppy disk drive is the mounting point for a boot disk, and can also store archived system images.

Description

The floppy drive is a standard 3.5-inch device with the data storage capacity of 1.44 MB. It receives DC power from the DC Distribution PCB, and exchanges data over a 34-conductor flat ribbon cable that connects directly to the Host Pentium CPU Motherboard or Single Board Computer.

Location

The floppy drive mounts in the External Interface Panel, which is located on the rear panel of the Workstation. Please refer to the following illustration.



Floppy Disk Drive Location

Circuit Description

The floppy disk drive is supplied by the manufacturer without a schematic or circuit description. It is very inexpensive, and much more practical to replace than repair.

Test Points

None available.

Circuit Breakers and Fuses

None available.

Troubleshooting

A bad floppy drive is the likely cause when the system fails to read from a floppy disk or write to it. If the system won't start from a boot disk, a bad floppy drive is also likely to be the cause. First check the power and data cable to the floppy drive. Make sure they are both connected and in good condition. If you see nothing wrong with the cables or connectors, replace the floppy disk drive.

Removal and Replacement

Follow these steps to replace the floppy disk drive:

1. Turn off Workstation and remove its AC power plug from wall outlet.
2. Remove left side cover of Workstation. This gives you access to floppy disk drive.
3. Remove four metric 6mm torx screws that secure floppy disk drive to Workstation chassis. Retain these screws for later use.
4. Disconnect power and data cables from floppy disk drive.
5. Pull floppy disk drive through rear panel.
6. Carefully push replacement drive through rear panel.
7. Carefully install power and data cables on replacement drive.
8. Install torx screws you removed in step 3 to secure replacement floppy disk drive to Workstation chassis.
9. Power up Workstation and check floppy disk drive for proper operation.
10. Install left side cover of Workstation.

Section 5 - High Resolution Displays

The following paragraphs describe the Workstation's two 16-inch, high-resolution monitors. This information is organized as follows:

References 5-2
Primary Display 5-2
Location 5-2
Circuit Description 5-2
Video Input 5-3
Digital Control Interface 5-4
Monitor Control Registers 5-6
Power Requirements 5-7
Test Points 5-7
AC Power 5-7
Composite Video 5-8
Serial Control Signals 5-8
Circuit Breakers and Fuses 5-8
Troubleshooting 5-8
Removal and Replacement 5-9
Secondary Display 5-10
Monitor Calibration 5-10

References

Please refer to **Workstation Interconnect Diagram 00-878981** as you read this section.

Primary Display

The left-hand monitor is called the Primary display because it shows newly-acquired images. It is functionally identical to the right-hand Secondary display. The usable screen area on each monitor is 14.53 diagonal inches.

Location

Section 2 of this manual shows a **front view** and a **rear view** of the High Resolution displays, which are located on top of the Workstation chassis. **Remove the Monitor Cover** as described in Section 2 to gain access to the display assemblies.

Circuit Description

Each monitor is a purchased part, and does not have a schematic diagram available. A detailed circuit description is therefore not possible. You must replace a faulty monitor as an assembly, which includes the monitor chassis, the CRT, video and deflection electronics, and an AC-powered switching power supply.

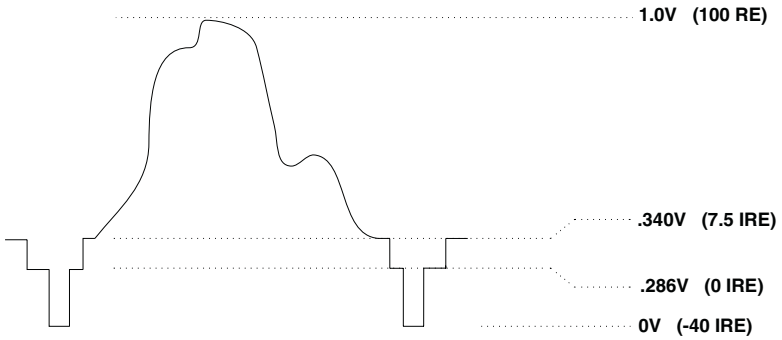
Video Input

Each monitor accepts standard-level (one volt peak-to-peak) composite video, and auto-selects one of the following horizontal frequency and vertical frequency combinations to match the horizontal and vertical timing of the current video input:

- Horizontal frequency of 61.80 kHz and a vertical frequency of 60 Hz
- Horizontal frequency of 77.25 kHz and a vertical frequency of 75 Hz
- Horizontal frequency of 60.02 kHz and a vertical frequency of 75 Hz

Regardless of timing characteristics, video input to either monitor must conform to RS-170 requirements, including:

- Negative polarity black
- Negative sync
- 1.0 Volt peak-to-peak amplitude
- 75 ohms input impedance (BNC connection)



RS-170 Video

Digital Control Interface

Each monitor has a digital control interface that allows it to accept asynchronous RS-232 control signals originating from the Host Pentium CPU, which transfers them through ISA slot 2 to U34, a quad UART on the **System Interface PCB**. The UART then passes the control signals through buffer U18, line driver U26, and **Electronics Box** connector P1 to each monitor. Each monitor reports status information back to the Host Pentium CPU along the same path.

In earlier versions of the system, the Host Pentium CPU consists of the **Host Pentium CPU Motherboard**. In current versions of the system, the Host Pentium CPU consists of the **Single Board Computer** and **Passive Backplane**.

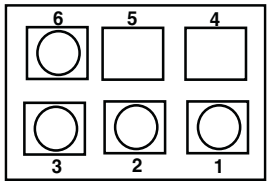
The asynchronous RS-232 interface on each monitor has the following characteristics:

- Eight-bit serial transfer with one start bit, one stop bit, and no parity bit
- 9600 baud data rate
- Monitor settings are updated via the serial link during vertical intervals for the CCD camera.

The RS-232 interface is a six-pin Molex Microfit connector (Molex #43045-0602) that has the following pinout:

Pin 1 - TxD
Pin 2 - RxD
Pin 3 - Ground
Pin 4 - Not used
Pin 5 - Not used
Pin 6 - +15 Volts (used by Host CPU to verify that monitor is ON)

P2



Monitor Serial Connector P2

Each monitor has the following service and setup controls. The controls marked with an asterisk are adjustable via the RS-232 interface and RUT. The other controls are factory adjustments that should not be tampered with in the field.

Focus
*Horizontal Size
*Vertical Size
Vertical Linearity
Horizontal Hold
*Horizontal Position
*Main Brightness
*Contrast
G2 (Grid 2) Control
*Vertical Position

CAUTION: *Don't try to manually adjust any monitor control or any monitor power supply control. Permanent damage to the monitor may otherwise result. Instead, use RUT to adjust the monitor as described under MONITOR CALIBRATION.*

Monitor Control Registers

Each monitor is equipped with 16 non-volatile EEPROM registers that store monitor configuration information during power-down periods. The monitors retrieve this data from EEPROM upon power-up, and configure themselves according to the data in the registers.

Power Requirements

Each monitor is equipped with an integral AC-operated synchronous switching power supply. AC power from TB4 (a terminal block at the rear of the Workstation centered below the monitors) enters a three-wire AC line at the rear of each monitor. Conductor identification is as follows:

Green/yellow - Chassis ground
Blue - Neutral
Black - Line

Each AC power supply accepts an input voltage between 90 and 135 VAC.

Test Points

There are no accessible test points on either monitor. However, you can check for AC power by probing TB4, check for video input by checking the video cable, and checking serial control signals by probing TB4, the video input cable, or the serial communications connector at the rear of each monitor.

AC Power

***WARNING**: Perform the following step carefully to avoid dangerous AC line electric shock.*

Both monitors should be active any time the Workstation is powered up. Carefully probe TB4 to make sure each monitor is receiving 115 VAC power.

Composite Video

You can observe the video signal to either monitor by removing the BNC connector from the video input jack and checking for the presence of **composite video** on the video cable.

Serial Control Signals

Each monitor accepts serial control signals from the Host CPU on connector P2, which is directly below the video BNC connector on the rear panel of each monitor.

P2-1 and P2-2 are at -8 Volts during normal operation. You will see activity on these pins only when you use the RUT utility to make adjustments to the monitor's brightness or contrast.

P2-6 should be at +11 Volts while the associated monitor is in the ON condition.

Circuit Breakers and Fuses

No monitor circuit breakers or fuses are accessible for servicing purposes.

Troubleshooting

When a monitor fails to operate, first make sure it is receiving AC power and an active composite video signal. If things look OK there, use RUT to determine if the monitor properly reports adjustment parameters and responds to adjustment commands. Replace a monitor when it fails to respond to RUT commands, fails to report the ON status, or does not respond to an active video signal.

Removal and Replacement

Follow these steps to replace the Primary monitor:

1. Disconnect Workstation's AC line plug from AC outlet.
2. Remove **monitor cover** and set it aside.
3. Disconnect video cable from BNC connector at rear of monitor and move it out of the way.
4. Disconnect serial data cable from **P2** at rear of monitor and move it out of the way.
5. Disconnect monitor's AC power line from **TB4**.
6. Remove two torx screws that secure touch screen brace to touch screen bracket. Remove cables from cable routers on brace, and set brace and screws aside.
7. Remove four torx screws that secure monitor to rear mounting brackets.
8. Carefully left monitor assembly from Workstation.
9. Carefully set replacement monitor into Workstation.
10. Install four torx screws you removed in step 7. If necessary, adjust mounting brackets so CRT face fits snugly against monitor bezel.
11. Install touch screen brace you removed in step 6. Place cables back in cable routers.
12. Connect replacement monitor's AC power line to TB4. **Individual conductors are color coded**.
13. Connect serial cable you disconnected in step 4 to P2 on replacement monitor.
14. Connect video cable you disconnected in step 3 to video BNC connector on replacement monitor.
15. Connect Workstation's AC line plug to active AC outlet.
16. Turn on Workstation and perform **Monitor Setup** as described in Section 12 of this manual.
17. After monitor is correctly adjusted, install monitor cover and return Workstation to normal operation.

Secondary Display

The Secondary display is the right-hand monitor. It's functionally identical in every respect to the Primary display. Physically, the Secondary monitor chassis is a mirror image of the Primary Display.

The **Touch Screen assembly**, located under the monitor bezel and surrounding the Secondary display's CRT, is functionally separate from the Secondary display, and is discussed in detail in Section 8 of this manual.

To replace the Secondary display, follow the **Removal and Replacement procedure for the Primary Display**.

Monitor Calibration

Refer to **Monitor Setup** in Section 12 of this manual for complete instructions on how to calibrate the size, brightness, and contrast of each Workstation monitor.

Section 6 - Cine Disk Subsystem

This section describes the Cine Disk Subsystem. It is organized as follows:

References 6-2
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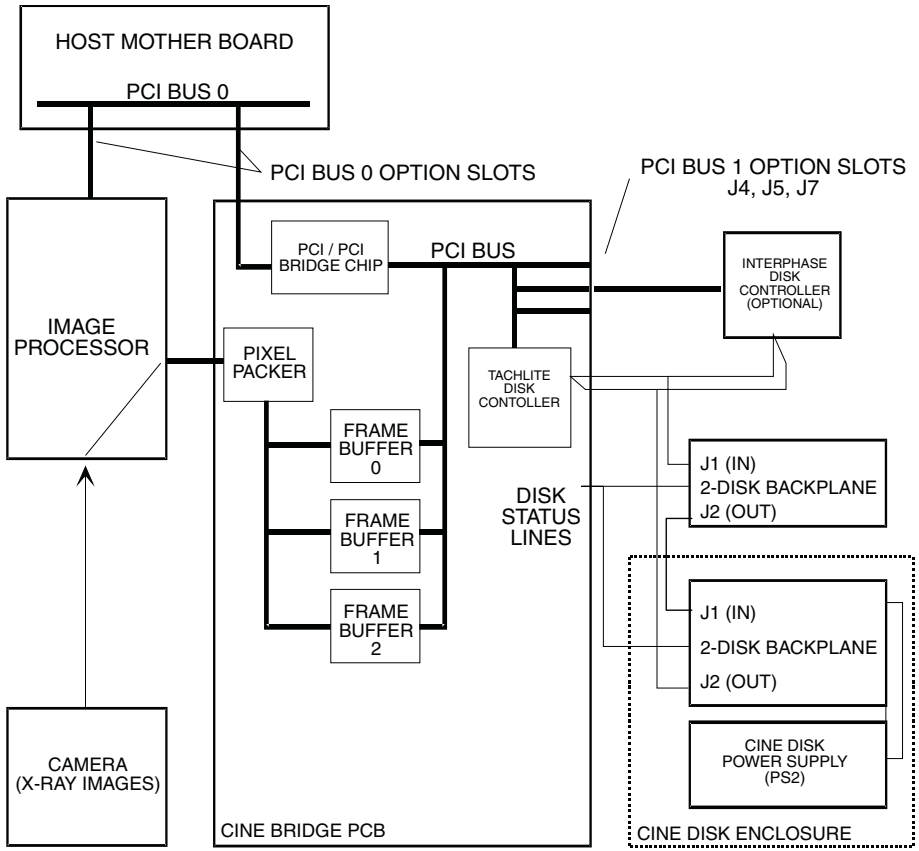
Circuit Description 6-5
Test Points....6-5
Circuit Breakers and Fuses 6-5
Troubleshooting....6-6
Removal and Replacement 6-7
Cine 2-Disk and Cine 4-Disk Backplanes 6-8
Location....6-8
Circuit Description 6-8
Test Points....6-9
Circuit Breakers and Fuses 6-9
Troubleshooting....6-10
Removal and Replacement 6-10

References

Refer to **Cine Bridge PCB Schematic 00-880921-01** and to the following block diagram when reading this section.



Cine Disk Subsystem Block Diagram

Cine Bridge PCB

The Cine Bridge is the interface between the Image Processor PCB and the Cine Disk Drives. The Cine Bridge PCB controls the data flow via commands from the host processor.

During a data storage operation, digital image information is passed from the Image Processor PCB to the Cine Bridge PCB through a dedicated connection. The image data from the Image Processor is packed into a format suitable for disk storage and placed into memory buffers. The memory buffers are accessible by the Tachlite Disk Controller through a PCI Bus port.

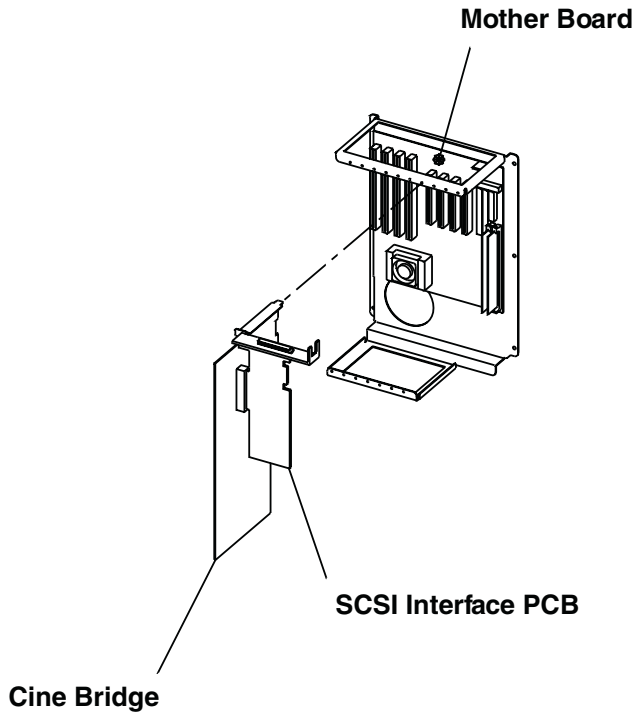
During data retrieval operation, packed data from the Tachlite Disk Controller is written into the memory buffer through a PCI Bus port. These memory buffers are then unpacked and presented to the Image Processor in the original digital image format through the dedicated connection.

In addition to the data flow interface, the Cine Bridge PCB contains two separate PCI Buses that are separated by a PCI to PCI Bridge. The PCI to PCI Bridge is intended to separate the host processor's PCI Bus (PCI Bus 0) from the second PCI Bus (PCI Bus 1) that is dedicated to the high data transfer rates between the memory buffers and the Tachlite Disk Controller.

The Cine Bridge PCB also has a spare Command Memory accessible to the PCI Bus. And a PCI Bus accessible port that provides information concerning the disks installed in the disk array.

Location

The Cine Bridge PCB connects directly to the host PCI Bus (PCI Bus 0) as shown in the following illustration.



Location of Cine Bridge PCB in Workstation.

Circuit Description

The primary purpose of the Cine Bridge PCB is to send and receive images to and from the Image Processor PCB. The Cine Bridge PCB uses the PCI Bus as a transmission medium for image data. The Cine Bridge is responsible for preparing the image data for access by the PCI Bus. Preparation is done through a set of image buffers that appears as memory accessible to the PCI Bus.

The secondary purpose of the Cine Bridge PCB is to provide a bridge to the host's PCI Bus. This allows the use of a PCI Bus dedicated to the transmission of image data to the Tachlite Disk Controller. The isolation of a secondary PCI Bus from the host PCI Bus is important to prevent the host bus arbitration functions from breaking up the long bursts required for the high data rate transfers. The secondary PCI Bus also extends the number PCI devices that can be in operation on the Workstation system.

***Note**: It is important not to install any PCI card into the secondary PCI Bus that will interfere with data transfer performance.*

The Cine Bridge PCB also assists operation of the Tachlite Disk Controller by providing a PCI accessible memory and cine drive monitoring. The memory functions as a temporary buffer for command data to the Tachlite Disk Controller. The device monitoring functions permits host applications to determine the status of the Cine drives.

Test Points

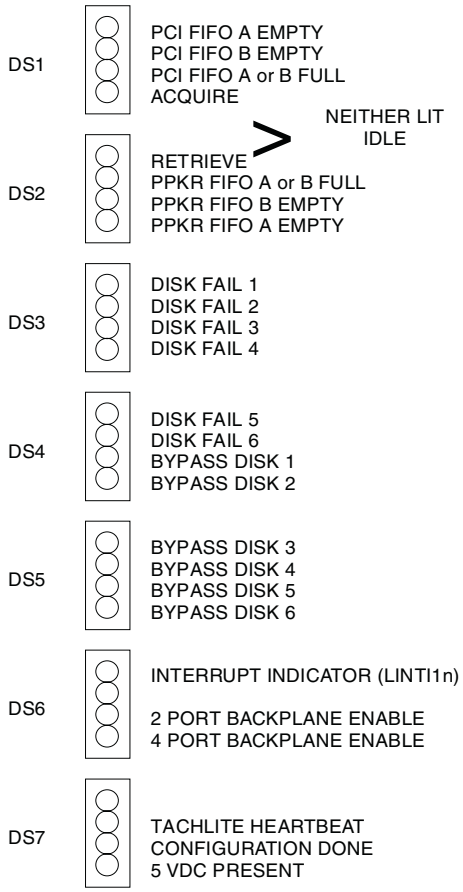
There are no useful test points on the Cine Bridge PCB.

Circuit Breakers and Fuses

There are no circuit breakers or fuses on the Cine Bridge PCB.

Troubleshooting

LEDs on the Cine Bridge PCB monitor its status. Please refer to the following illustration for details.



Cine Bridge PCB Status LEDs

The RUT (Remote Utilities Tool) can be used to check the communications of the Fibre Channel cables. If a cine prepare can be successfully accomplished, the Fibre Channel communications are good. Additionally, you can use RUT to test the cine disk data throughput after a cine prepare has been performed. If one cine disk is bad, the disk transfer rate will be below the required rate.

***Note**: Refer to the on-line help supplied with RUT for detailed instructions on how to check the fibre channel cables.*

***Note**: If communication with the cine drives fails, make sure the Fibre Channel cables are not reversed where they connect to the 2-Disk or 4-Disk Backplanes. Reversal of the Fibre Channel cables does not damage circuitry, but communications with the drives does not work.*

You also can use the green LED indicators on the Cine Bridge PCB to check communications with the cine drives at boot-up. If the LEDs do not flicker, there is a good chance that the Fibre Channel cables are either installed backwards or they have failed. Also be sure that power is connected to the 2-Disk or 4-Disk Backplanes. If the cables are installed correctly and the power is OK, there is a good chance that the Cine Bridge PCB has failed.

Removal and Replacement

1. Turn off the power to the Workstation.
2. Remove the SCSI Interface PCB from the Cine Bridge PCB by removing the 6-32-3/8-inch screw located on top of the PCB.
3. Disconnect the PCB from the port.
4. Remove the two 6-32-3/8-inch screws that hold the board to the card rack. One screw is on the top and one screw is on the bottom of the board.
5. Grip the board and pull outward until it is clear from the card rack.
6. Disconnect the SCSI Interface card rack from the Cine Bridge PCB.

Perform the steps in reverse order to install a new Cine Bridge PCB.

Cine 2-Disk and Cine 4-Disk Backplanes

The following paragraphs describe the cine disk backplanes.

Location

The Cine 2-Disk backplane is located inside the Electronics box on the lower right hand side behind the Cine Hard Disk(s), attached to a bracket.

The Cine 4-Disk backplane is located outside the Electronics box in its own chassis. It is in the front area of the Workstation where the Lenzar is installed.

Circuit Description

The backplanes provide power to each Cine disk drive. Power to each disk drive goes through the same disk drive connector as data (unlike standard disk drives where power is applied through a separate connector). Each backplane also has a looping input and output FC-AL connector for serial input and serial output data.

The disk drives are essentially SCSI disk drives with one difference; rather than transferring SCSI commands/data via a standard SCSI parallel ribbon cable, commands and data are packetized and placed on the Fibre Channel Arbitrated Loop (FC-AL). The drives contain circuitry that packetized/unpacketized the data and commands. Commands are re-generated into the original SCSI command.

The FC-AL (Loop) is designed so that up to 6 drives can be installed without the need for disk configuration or jumper selection.

Due to the “looping” architecture of FC-AL, a break anywhere in the loop causes the entire loop to fail. To enable the backplane to be short-stuffed (for example, with three drives instead of four), each drive has a corresponding “Loop Resiliency Circuit” or LRC. The LRC allows the high-speed data to bypass the missing disk drive.

Each disk drive contains detection circuitry to determine if the drive is capable of placing itself in the loop. If a drive determines it is operating properly, the drive waits for an “idle” on the loop and then places itself in the loop. Each drive provides an output signal called “BYPASS” that controls its corresponding LRC.

In addition to the BYPASS output signal, each drive provides a FAIL output signal. Some important differences exist between the BYPASS and FAIL signals. Each disk drive contains two logical hardware sections – a SCSI-3 disk drive section and the FC-AL section. A FC-AL disk drive is actually a SCSI-3 disk drive with a high-speed Fibre Channel serial loop attached rather than the parallel SCSI bus. The SCSI portion of the hardware generates the FAIL output signal. The FC-AL portion generates the BYPASS output signal.

If a drive fails but is still capable of placing itself in the loop, it will place itself in the loop so software diagnostics can be run. On the other hand, if a failure is detected in the high-speed FC-AL section, the drive will take itself off the loop (or never put itself on the loop) by forcing BYPASS low.

The status of the entire cine disk array is obtainable by reading the state of the six BYPASS status lines and six FAIL status lines (P4). Additionally, the 4-Disk Backplane provides a “4-disk installed” status line that can be used to determine if the 4-Disk Backplane is in the loop. The 2-Disk Backplane provides its own 2-disk installed status signal. Software has the ability to determine which backplanes are in the loop.

To check this status, look at the Cine Bridge PCB LEDs.

Test Points

There are no useful test points on the Cine Disk Backplanes.

Circuit Breakers and Fuses

There are no circuit breakers or fuses on the Cine Disk Backplanes.

Troubleshooting

A failure of the 4-Disk Backplane that prevents data from transmitting around the loop renders the entire Cine Disk Subsystem unusable. Whether the loop breaks due to a Cine Power Supply failure, component failure in the loop itself or Fibre Channel cable failure, the result is the same.

If the fault is in the 4-Disk Backplane, replace the backplane.

***Note**: A loop failure does not prevent the 9800 System from being used to take and display live X-ray images. The images simply cannot be recorded or played back using the Cine Subsystem.*

Removal and Replacement

Use the following procedure to remove and replace the 2-Disk Backplane.

1. Remove the four 6-32x3/8-inch Torx Pan Head screws that secure the Hard Drives to the Hard Drive bracket.
2. Remove the two Cine disk hard drives.
3. Remove the six 6-32x3/8-inch Torx Pan Head Screws from the Hard Drive Mount bracket.
4. Remove the 2-Disk Backplane from the Hard Drive bracket.

Reverse the steps above to install a new backplane.

Use the following procedure to remove and replace the 4-Disk Backplane.

1. Remove the front and left side panels. (As you look at the Workstation from the front.)
2. Remove two 8-32x3/8-inch Torx Pan Head screws that hold the Cine Drive mount up in the vertical position.
3. Bring down the Cine Drive mount bracket to the horizontal position. It will be held in position with a Lanyard cable.
4. Remove all sixteen 6-32x3/8-inch Torx Pan Head screws from all four Cine Drives.
5. Remove all four Cine Drives from the 4-Disk Backplane.
6. Remove the eight 6-32x3/8-inch Torx Pan Head screws from the 4-Disk Cine Backplane.
7. Remove the 4-Disk Backplane from the Drive Bracket.

Reverse the steps above to install a new backplane.

Section 7 - Image Subsystem

The Image Subsystem processes video from the CCD Camera to produce enhanced images for the Display Subsystem monitors and Cine Disk Subsystem. The Image Subsystem also produces standard resolution interlaced video for the optional VCR. It also produces digitized images for the DICOM interface, optional laser camera, and optional hardcopy devices. The Image Subsystem includes the Video Controller PCB, Image Processor PCB, and Display Adapter PCB, all of which are located in the Workstation's Electronics Box.

This section is organized as follows:

Video Controller PCB 7-3
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- Circuit Description 7-5
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  - Pilot Tone Path 7-5
  - VCR Video Path 7-6
- Test Points 7-6
- Circuit Breakers and Fuses 7-6
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Image Processor PCB 7-9
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Display Adapter PCB 7-14
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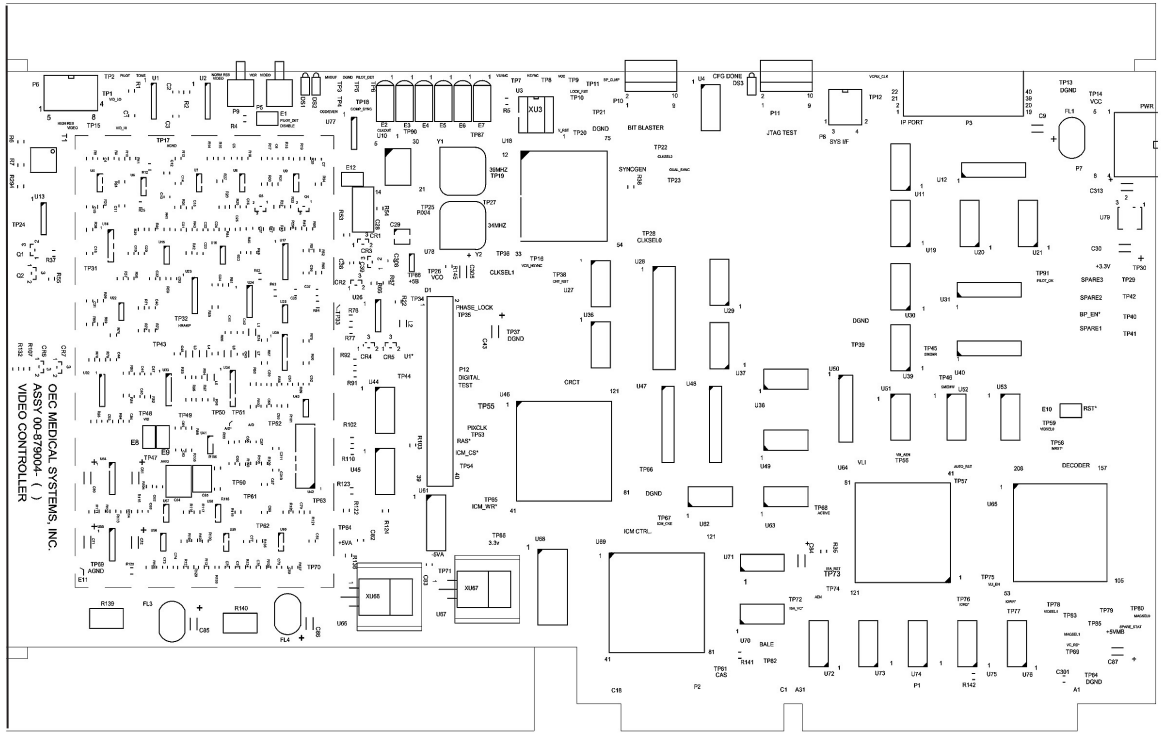
Video Controller PCB

The Video Controller PCB accepts analog differential video and pilot tone (sync) signals from the CCD camera. The pilot tone signal contains sync, drive, and pixel clock data. The Video Controller converts the analog video signal to parallel digital data, and sends it to the Image Processor PCB.

The Video Controller performs Genlock control for the Workstation, anti-aliasing and anti-vignetting of the digital X-Ray images, and creates the VLI window needed for the X-Ray Generator to perform Automatic Brightness Stabilization.

Location

The Video Controller PCB mounts in ISA slot 1 on the Host Pentium motherboard or the Passive Backplane. The following assembly drawing shows the major components on the board.



Video Controller PCB

Circuit Description

Please refer to **Video Controller Schematic 00-879002** while reading the following information.

The Video Controller is a complex PCB with many surface mount components. While repair of this board in the field is not practical, it is important to understand its basic functions so you can replace it when it is faulty.

CCD Video Path

Differential analog video from the CCD camera enters the Workstation over the Lemo cable, and enters the Video Controller on P6. From there, CCD video travels through op amp U5 to mux U14. ISA bus address decoder U65 selects the video through video separator U22 and into voltage-controlled gain amplifier U32, which combines the video with horizontal and vertical sync signals that have been anti- vignette processed by U23, U54, U55, U57 and U60. The composite video signal out of U33 is scaled by a mag select signal from ISA bus decoder, and then passes through a 25 MHz anti-alias, low-pass filter to a differential amplifier consisting of U51 and U56. Analog to digital conversion of the high resolution video takes place in U42, which passes the digital video signal through pixel interpolator U46 before passing it on to the Image Processor.

Sync Stripper U17 produces a composite sync signal from the high resolution video signal. Sync generator U18 produces the back porch clamp, horizontal sync, and vertical sync from this composite sync signal. The synch generator also produces a video select signal that turns on the 25 MHz anti-alias LP filter.

Pilot Tone Path

The Pilot Tone (synchronization) signal from the CCD camera enters the Workstation over the Lemo cable, and enters the Video Controller PCB on P6. The Pilot Tone signal travels through transformer T1 to differential amplifier U1, and then triggers flip flop U2, producing a PILOT_DET signal. The PILOT_DET signal triggers sync generator U18, which then generates the pixel clock, horizontal sync, vertical sync, and field index signals. The Video Controller PCB passes these signals on to the Image Processor PCB.

VCR Video Path

Composite video from the VCR enters the Workstation through BNC connector J6, and enters the Video Controller on J5. From there, the video travels through op amp U8 to mux U14. ISA bus address decoder U65 selects the video through video separator U22 bypassing voltage-controlled gain amplifier U32. The composite video signal out of U33 passes through a 5 MHz anti-alias, low-pass filter to a differential amplifier consisting of U41 and U56. Analog to digital conversion of the VCR video takes place in U42, which passes the digital video signal through pixel interpolator U46 before passing it on to the Image Processor.

Sync Stripper U6 produces a composite sync signal from the VCR's video signal. Sync generator U18 produces the back porch clamp, horizontal sync, and vertical sync from this composite sync signal. The sync generator also produces a video select signal that turns on the 5 MHz anti-alias LP filter.

Test Points

Although there are several test points along the front edge of the Video Controller PCB, none are really useful in troubleshooting the board. There is no extender for the card, so test points not along the front edge of the card are not accessible.

Circuit Breakers and Fuses

There are no circuit breakers or fuses on the Video Controller PCB.

Troubleshooting

Symptoms that indicate possible Video Controller PCB failure include:

- Unstable image - sync detector/generator failure
- Video noise - A/D failure
- Pixel blemishes - failure to correct for pixel gain and/or offset. Interpolation errors. Decoder failure.
- Rolling or torn image - Decoder failure
- Wrong video source - Decoder failure
- No image display - PIXCLK generation failure
- Incorrect patient dose - VLI failure

The Video Controller PCB has three LEDs that can provide limited troubleshooting help.

Removal and Replacement

Follow these steps to replace the Video Controller PCB:

1. Turn off the Workstation and unplug it from the AC outlet.
2. Remove the Workstation Front Cover.
3. Open the Electronics box and locate the **Video Controller PCB**.
4. Remove the two screws that secure the PCB to the Electronics box.
5. Carefully remove all cables connected to the front edge of the PCB. If necessary, tag connectors for easier identification later.
6. Withdraw PCB from Electronics box and place in antistatic bag
7. Connect cables you removed in step 5 to replacement Video Controller PCB.
8. Install replacement Video Controller PCB in Electronics box.
9. Install screws you removed in step 4.
10. Connect Workstation to AC outlet and test it for proper operation.
11. Close Electronics box.
12. Install Workstation Front Cover.

Image Processor PCB

As its name implies, the Image Processor PCB manipulates the digital video from the Video Controller PCB to produce the following effects and functions in the displayed image:

- Vertical and horizontal image reversal.
- Circular blanking
- Window and level control
- Automatics sample window positioning
- Real-time image edge enhancement
- Subtraction
- Peak opacification
- Zoom and roam
- Cine interface generation
- Text and graphics for image annotation.

Location

The Image Processor PCB mounts in PCI slot 6 on the Host Pentium motherboard or the Passive Backplane. The following assembly drawing shows the major components on the board.

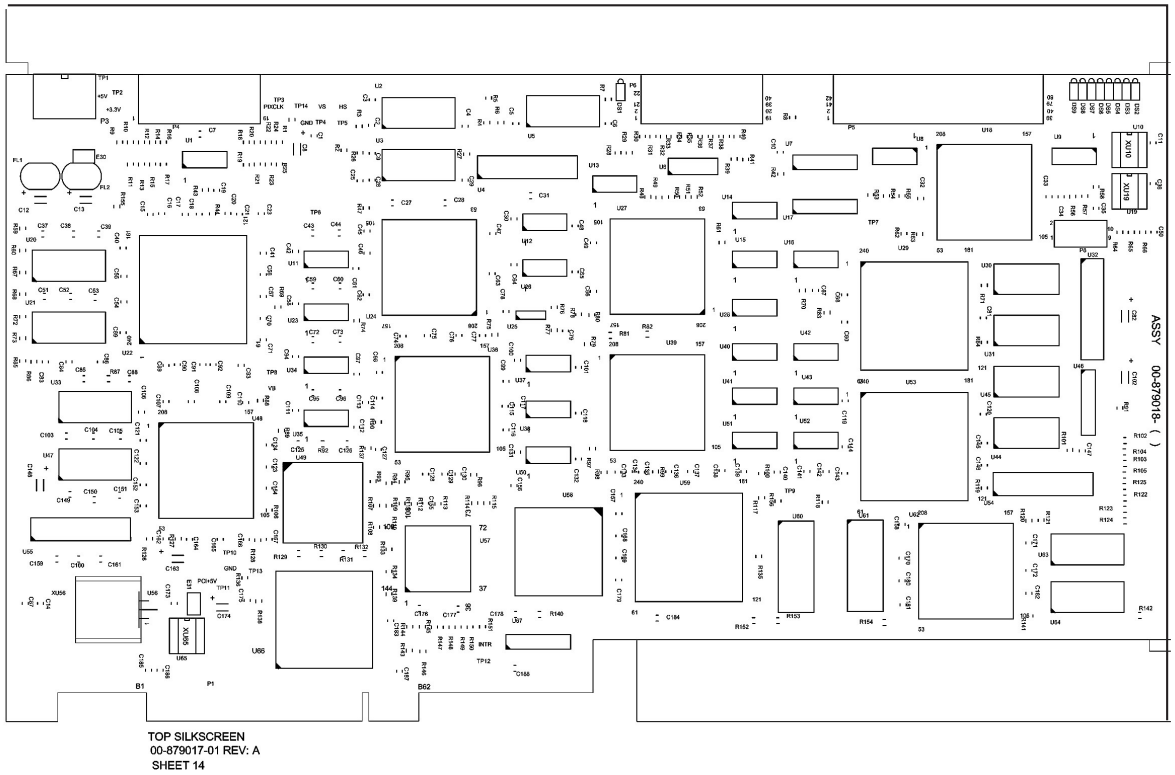


Image Processor PCB

Circuit Description

Please refer to **Image Processor Schematic 00-879016** while reading the following information.

Like the Video Controller, the Image Processor is a complex PCB with many surface mount components. The following paragraphs will help you understand the circuitry on a basic level so you can determine when the board has failed.

The Image Processor PCB has five connectors:

P1 is the PCI connector. It connects PCI slot 6 on the Host Pentium motherboard or Passive Backplane. The board receives commands and reports data back to the Host Controller over this connection.

P2 is not an assigned designator on the Image Processor PCB; this connector does not exist.

P3 receives + 5 VDC power from the DC Distribution board. P3-1 is the +5 Volt sense line. Sense is measured on the **System Interface PCB**. P3-2 and P3-6 are +5 Volts, and P3-5 and P3-8 are ground.

P4 receives digital video from the Video Controller PCB.

P5 is the digital video output to the Display Adapter PCB.

P6 is the digital video connector to the Cine Bridge PCB.

P7 is not an assigned designator on the Image Processor PCB; this connector does not exist.

P8 is the Altera Configuration Connector. It is not used.

Test Points

Although there are a few test points along the front edge of the Image Processor PCB, none are really useful in troubleshooting the board. There is no extender for the card, so test points not along the front edge of the card are not accessible.

Circuit Breakers and Fuses

There are no circuit breakers or fuses on the Image Processor PCB.

Troubleshooting

Symptoms that indicate possible Image Processor PCB failure include:

- Workstation lockup or failure - Look for power failure on P3.
- No response from PCI bus - Failure of the PCI9050 interface chip.
- System lockup - Missing or failure of Pixel Clock from the Video Controller PCB.
- No display - Missing or failure of Pixel Clock from the Video Controller PCB.

The Image Processor PCB has nine LEDs that can provide limited troubleshooting help.

Removal and Replacement

Follow these steps to replace the Image Processor PCB:

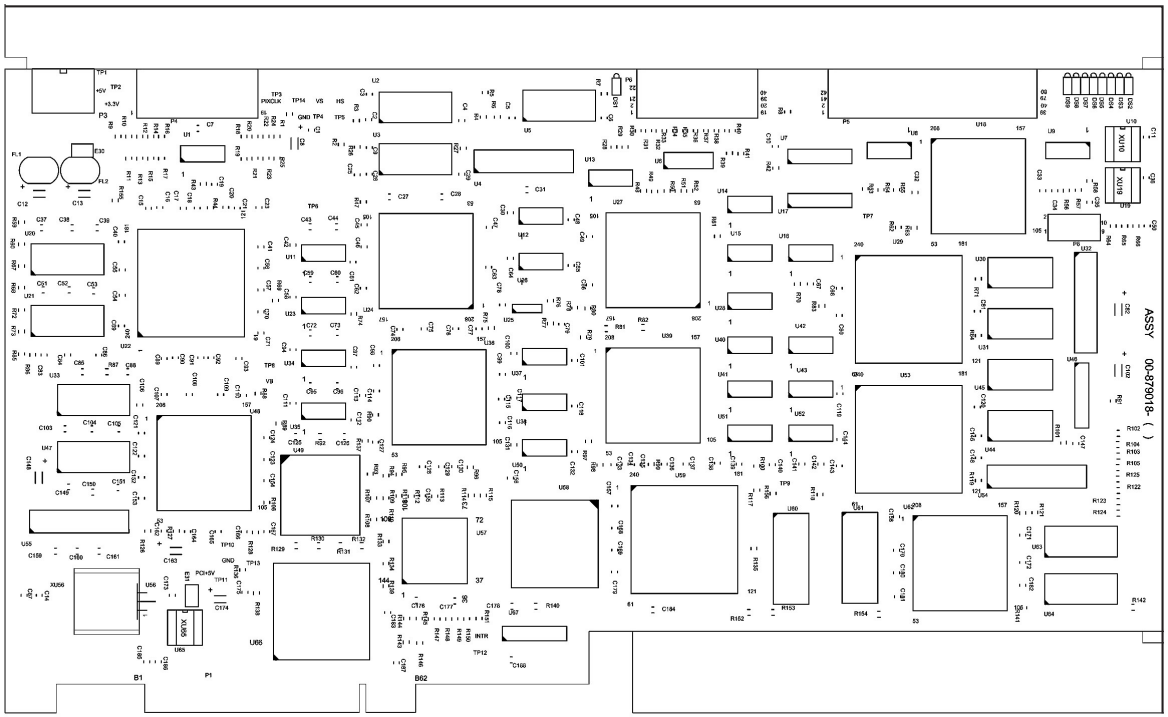
1. Turn off the Workstation and unplug it from the AC outlet.
2. Remove the Workstation Front Cover.
3. Open the Electronics box and locate the **Image Processor PCB**.
4. Remove the two screws that secure the PCB to the Electronics box.
5. Carefully remove all cables connected to the front edge of the PCB. If necessary, tag connectors for easier identification later.
6. Withdraw PCB from Electronics box and place in antistatic bag
7. Connect cables you removed in step 5 to replacement Image Processor PCB.
8. Install replacement Image Processor PCB in Electronics box.
9. Install screws you removed in step 4.
10. Connect Workstation to AC outlet and test it for proper operation.
11. Close Electronics box.
12. Install Workstation Front Cover.

Display Adapter PCB

The Display Adapter PCB translates the 25 or 30 FPS non-interlaced 1024 x 1024 images generated in the Image Processor to 75 Hz non-interlaced video for the high-resolution display monitors. The Display Adapter also converts the non-interlaced Image Processor video to interlaced video that is compatible with PAL or NTSC video cassette recorders. The board also has a printer interface that transmits digital images to the hardcopy (Lenzar) camera.

Location

The Display Adapter PCB mounts in PCI slot 5 on the Host Pentium motherboard or the Passive Backplane. The following assembly drawing shows the major components on the board.



Display Adapter PCB

Circuit Description

Please refer to **High Resolution Display Adapter Schematic 00-881445** while reading the following information.

The Display Adapter is a complex PCB with a high percentage of surface mount components. It is not practical to service this board in the field. You should replace it if you believe it has failed.

The Display Adapter performs the following tasks:

- Accepts commands from and supplies data to the Host Controller.
- Latches in digital video from the Image Processor over P9.
- Buffers digital video for the left monitor, right monitor, and VCR.
- Performs digital-to-analog conversion of digital data for left monitor, right monitor, and VCR.
- Buffers analog video to left monitor, right monitor, and VCR.

Test Points

TP10 - Fast Scan Video to Left Monitor

TP15 - Fast Scan Video to Right Monitor

Circuit Breakers and Fuses

There are no circuit breakers or fuses on the Display Adapter PCB.

Troubleshooting

Symptoms that indicate possible Display Adapter PCB failure include:

- No video - Indicates possible failure of +5-Volt supply, ±12-Volt supply, or both
- VCR records poor picture or no picture - Failure of scan conversion circuits
- Hardcopy camera fails - printer port failure (P11)
- Display Adapter does not respond to PCI bus - PCI9050 chip failure
- System locks up - Missing or failure of pixel clock from input connector

The Display Adapter PCB has a few LEDs that are of limited troubleshooting value.

Removal and Replacement

Follow these steps to replace the Display Adapter PCB:

1. Turn off the Workstation and unplug it from the AC outlet.
2. Remove the Workstation Front Cover.
3. Open the Electronics box and locate the **Display Adapter PCB**.
4. Remove the two screws that secure the PCB to the Electronics box.
5. Carefully remove all cables connected to the front edge of the PCB. If necessary, tag connectors for easier identification later.
6. Withdraw PCB from Electronics box and place in antistatic bag.
7. Connect cables you removed in step 5 to replacement Display Adapter PCB.
8. Install replacement Display Adapter PCB in Electronics box.
9. Install screws you removed in step 4.
10. Connect Workstation to AC outlet and test it for proper operation.
11. Close Electronics box.
12. Install Workstation Front Cover.

Section 8 - User Interface

This section describes the following Workstation user interfaces.

- Control Panel Processor
- Infrared Remote Control and Sensor
- Keyboard
- Touch Screen
- X-Ray On Indicator

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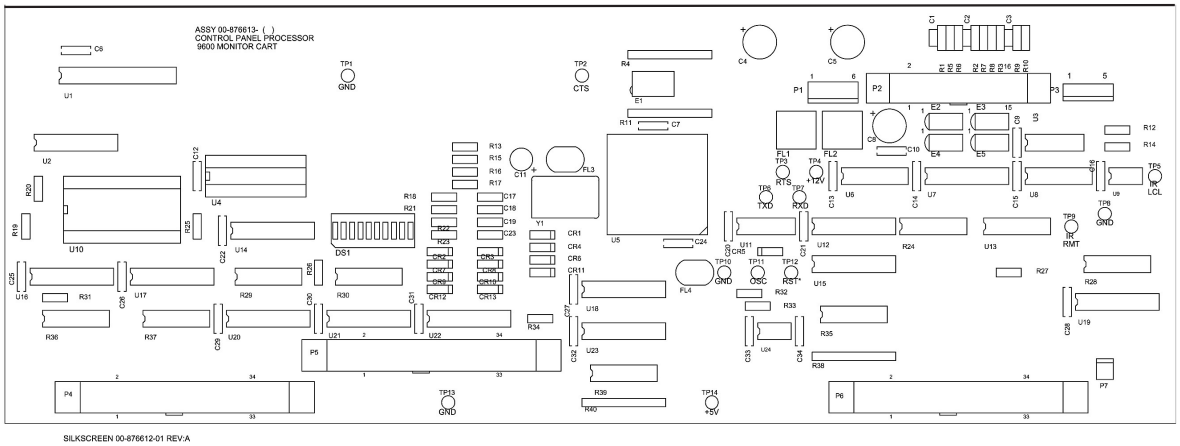
Control Panel Processor

The Control Panel Processor (CPP) scans for key closures on the Keyboard and reports these closures to the **System Interface PCB** for further processing. The CPP also responds to commands from the System Interface PCB to light Keyboard LEDs.

Location

The Control Panel Processor PCB is located directly beneath the Keyboard. The following is an assembly drawing of the board.



Control Panel Processor PCB

Circuit Description

Please refer to **Control Panel Processor Schematic Diagram 00-876611** while reading the following description.

Microcontroller

U5 is a CHMOS 16-bit 80C196KC microcontroller. Y1 clocks the chip at 12 MHz. The microcontroller has four 8-bit ports (P0 through P3) and eight high speed serial ports (HSI0 - HSI3 and HSO0 - HSO5).

Port HSO0 and its inverse (U11-F) drive two inputs on U13, which is a four-channel push-pull driver. This chip provides a differential 12 Volts DC to operate a piezo alarm connected to P7. Software toggles this port to generate tones of variable frequency and duration. The alarm device can deliver between 60 and 80 dB from 200 Hz to 2 kHz. Volume is not adjustable.

Microcontroller Reset and Watchdog Circuitry

Reset circuitry consists of U24, pullups R32 and R33, two Schmidt trigger inverters on U2, and schottky diode CR1. U24 is a power-up reset generator and watchdog timer. The reset output of this device is held low when the +5 volt supply is less than 4.65 Volts and remains low for 50 ms after the supply rises above 4.65 Volts. This ensures a clean reset signal during power failure and brownout conditions. The power fail feature of U24 is not used.

To reset the microcontroller its reset pin (U5-16) must be low for at least 2.7 µs after the power supply stabilizes. The Schmitt trigger inverter provides a clean transition for the reset signal. The reset signal is also applied to U4 to disable all address decoding.

The watchdog circuit is driven from microcontroller's port 1, bit 1 into pin 6 of U24. This line must toggle continuously and faster than every 1.6 seconds to prevent a reset.

Address Decoding

U2, U14 and U4 provide address decoding of the microcontroller bus.

Diagnostic LEDs

DS1 is a 10-segment LED bargraph that software uses to display status information. Its segments have the following meanings:

DS1-1 lights when you press buttons on the icon keyboard.

DS1-2 lights when you press buttons on the text keyboard.

DS1-3 is not used.

DS1-4 is not used.

DS1-5 lights when IR data from the remote control is being received.

DS1-6 lights when the audible alarm is on.

DS1-7 lights when the Control Panel Processor PCB receives data from the **System Interface PCB**.

DS1-8 lights when the Control Panel Processor PCB sends data to the System Interface PCB.

DS1-9 is not used.

DS1-10 blinks when the microcontroller is running.

Infrared Remote Input and Power Supply

Optoisolator U9-7 generates a pulse train in response to actuation of the remote control. U8-5 is always high, enabling the pulse train through U3. The pulse train generates interrupts on P2.2 of the microcontroller.

P3 supplies +12 Volts to the IR receiver, which regulates it down to +5 Volts to operate the IR receiver circuitry.

Serial Communications with System Interface PCB

The Control Panel Processor uses RS232 serial communications to communicate with the System Interface PCB. The microcontroller uses a MAX233 line driver/receiver (U7) to communicate over J2 with an identical MAX233 on the System Interface PCB. The communications rate is 9600 baud.

Test Points

TP1 Ground
TP2 Clear to Send
TP3 Request to Send
TP4 +12 Volts
TP5 Pulses from IR Remote
TP6 Transmit Data
TP7 Receive Data
TP8 Ground
TP9 +5 Volts (U8 is not used)
TP10 Ground
TP11 12 MHz microcontroller clock
TP12 Watchdog reset
TP13 Ground
TP14 + 5 Volts

Circuit Breakers and Fuses

There are no circuit breakers or fuses on the Control Panel Processor PCB.

Troubleshooting

The fastest way to troubleshoot the Control Panel Processor PCB is to monitor its **Diagnostic LEDs**. The following general guidelines also apply.

- When keyboard or diagnostic LEDs fail to operate, look for failure in the associated LED driver.
- If the infrared remote doesn't work and the batteries are OK, look for failure of U8 or U9.
- If the system doesn't respond to key closures or responds erroneously, look for failure in row output or column input circuitry. Bad pullup resistors on these lines can also cause incorrectly decoded key closures.

Removal and Replacement

1. Turn off Workstation and remove its plug from the AC outlet.
2. Remove the **Keyboard** from the Workstation.
3. Disconnect all cabling from the Control Panel Processor PCB. Tag the cables to permit easier reinstallation.
4. Remove the mounting hardware and lift the Control Panel Processor from the Workstation.
5. Place removed Control Panel Processor PCB in antistatic bag.
6. Install replacement Control Panel Processor in Workstation and secure mounting hardware.
7. Connect cabling you removed in step 3.
8. Install Keyboard in Workstation.
9. Power up system and check for proper operation.

Infrared Remote Control and Sensor

The Infrared Remote subsystem consists of a battery-operated, handheld remote control and an infrared receiver that mounts between the monitors.

Location

On the remote control and receiver assembly.

Circuit Description

Please refer to **Infrared Receiver Schematic 00-879378** while reading the following information.

The remote control transmitter generates a 940 nm invisible light beam that strikes the photodiodes on the IR receiver PCB. U4 is a preamplifier that passes the signal though a 53.3 kHz bandpass filter consisting of L1 and C2. U2 amplifies the signal further and passes it though ambient noise filter U3. U1, Q1 and Q2 then demodulate the signal and pass it to the Control Panel Processor PCB.

The Infrared Receiver is powered by +12 Volts from the Control Panel Processor PCB.

Test Points

There are no test points on either the transmitter or receiver PCB.

Circuit Breakers and Fuses

There are no circuit breakers or fuses on either the transmitter or receiver PCB.

Troubleshooting

If the IR Remote Control doesn't work, follow these steps:

1. Operate the IR transmitter near a standard broadcast AM radio receiver tuned to an unused frequency with the volume up. If things are working normally, you should be able to hear the pulses as you press each transmitter button.
2. If step 1 produces negative results, check the batteries in the handheld transmitter. It requires three AAA alkaline cells. If replacing the batteries does not bring the transmitter to life, replace the transmitter.
3. Once you are sure the transmitter works, check DS1-5 on the Control Panel Processor PCB as you press buttons on the Infrared Remote. The LED should light each time you press a button. If DS1-5 doesn't light, replace the IR Receiver assembly.

Removal and Replacement

Follow these steps to replace the IR Receiver:

1. Turn off the Workstation and disconnect it from the AC outlet.
2. Remove the **Monitor Cover**.
3. Remove the torx screw that secures the IR Receiver assembly to the monitor bezel.
4. Disconnect the A31J1 from the IR Receiver assembly.
5. Install A31J1 on replacement IR Receiver assembly.
6. Mount replacement IR Receiver using torx screw you removed in step 3.
7. Turn on Workstation and check IR Remote for proper operation.
8. Install Monitor Cover.

Keyboard

The following paragraphs describe the Workstation's keyboard.

Location

The keyboard is located directly beneath the High Resolution monitors on the Workstation.

Circuit Description

The keyboard is a simple switch matrix with no active components. It consists of a PCB that mounts underneath a flexible, fluid-resistant membrane embedded with contactors that close switch contacts on the PCB when the operator presses the keys. Two ribbon cables connect the keyboard PCB to scanning circuitry on the **Control Panel Processor PCB**.

Test Points

No test points are available on the Keyboard PCB.

Circuit Breakers and Fuses

There are no circuit breakers or fuses on the Keyboard PCB.

Troubleshooting

Most Keyboard problems are associated with damage to the Keyboard membrane. A damaged membrane allows contamination from moisture or dirt to enter the contacts and cause unreliable operation. The solution to this is to remove the damaged membrane, clean the Keyboard PCB contact areas, and install a replacement membrane.

Removal and Replacement

Follow these steps to replace the keyboard membrane:

1. Turn off Workstation and disconnect it from AC outlet.
2. Remove six screws from bottom of Keyboard that secure it to Workstation chassis.
3. Gently pull Keyboard toward you. When Keyboard clears Workstation, turn it over and disconnect the two ribbon cables. Also remove the nut that secures the green and yellow ground wire to the Keyboard and disconnect the wire. Tag the ribbon cable connectors so you don't mix them up later.
4. Set the Keyboard upside down on a flat surface.
5. Remove 18 torx screws and washers to free Keyboard membrane and PCB from Keyboard bezel. Lift membrane and PCB away from bezel.
6. Align fingers on replacement membrane with holes in Keyboard PCB and gently press the membrane into place over the Keyboard PCB.
7. Align Keyboard and membrane with mounting holes in bezel and install screws/washers you removed in step 5. Secure the screws carefully and uniformly.
8. Install ribbon cables you removed in step 3. Install ground wire and secure nut.
9. Set keyboard in place on Workstation and install six screws you removed in step 2. Secure the screws.
10. Turn on Workstation and check Keyboard for proper operation.

Touch Screen

The right-hand monitor has an array of infrared LEDs and a corresponding array of phototransistors surrounding the CRT face that detects a finger touching or nearly touching the CRT, calculates the position of the finger, and sends this information back to the **System Interface PCB**. The operator uses this touch screen feature in conjunction with displayed software screens to make mode or function selections during Workstation operation.

Location

On the Touch Screen Assembly.

Circuit Description

The Touch Screen Assembly is an off-the-shelf item and no detailed circuit description is available for it.

The Touch Screen Assembly receives +12 Volts and +5 Volts from the **DC Distribution PCB**. It communicates with the System Interface PCB over a simple three-wire RS232 interface.

Test Points

There are no test points available on the Touch Screen interface, but you can observe RS232 signals and check power supply voltages on P1, which is available under the monitor bezel behind the right monitor. You have to remove the **Monitor Cover** to access this connector.

Circuit Breakers and Fuses

The Touch Screen Assembly has no circuit breakers or fuses.

Troubleshooting

If the Touch Screen Assembly does not produce RS232 activity when DC power is applied to it, replace the Touch Screen Assembly. You should be able to observe this activity on P1-2. Set your oscilloscope sensitivity for 5 Volts/division and the sweep at 1 millisecond per division.

Removal and Replacement

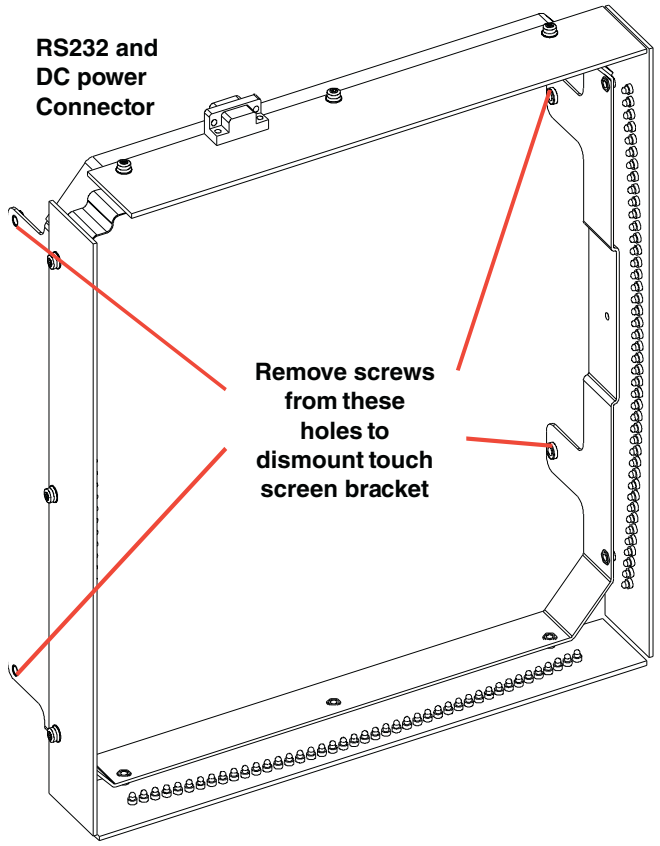
Follow these steps to replace the Touch Screen Assembly:

1. Turn off Workstation and disconnect its power plug from the AC outlet.
2. Remove **Monitor Cover**.
3. Remove 12 torx screws to loosen bezel from bezel frame.
4. Carefully remove X-Ray On light and IR Receiver assemblies from bezel. Set bezel aside.

***CAUTION**: Avoid shorting any electrical contacts in the next step.*

5. Use masking tape or similar non-conductive tape to secure X-Ray On light and IR Receiver Assembly to bezel frame. Be careful not to short out electrical contacts on either component.
6. Carefully mark position of left Monitor on Workstation chassis so you can accurately reposition Monitor later.

7. Loosen three screws that secure left Monitor to Workstation chassis. Carefully slide left Monitor back far enough to give access to Touch Screen Mounting Bracket screws that are located between the two monitors. (See following illustration)



Touch Screen Electronics and Mounting Bracket

8. Remove four torx screws that secure Touch Screen Mounting Bracket to right Monitor.
9. Disconnect serial cable from top of Touch Screen Assembly and remove Touch Screen Assembly from right monitor. Place removed Touch Screen Assembly in antistatic container.
10. Connect serial cable to replacement Touch Screen Assembly.
11. Mount replacement Touch Screen Assembly to right Monitor chassis using screws you removed in step 8.
12. Temporarily move left monitor back into position. Turn on Workstation and test Touch Screen assembly for proper operation.
13. When Touch Screen works properly, turn off Workstation and remove its AC plug from AC outlet.
14. Carefully move left monitor into position you marked in step 6. Secure three left Monitor mounting screws.
15. Mount X-Ray On light and IR Receiver to Monitor bezel.
16. Mount Monitor bezel to bezel frame using 12 screws you removed in step 3.
17. Install Monitor Rear Cover you removed in step 2 and return Workstation to service.

X-Ray on Indicator

The X-Ray On indicator lights any time the system generates X-rays. The indicator contains an array of six LEDs driven by a signal from the System Interface PCB.

Location

The X-Ray On indicator is located on top the left Monitor's bezel.

Circuit Description

The X-Ray On indicator is an array of six bipolar LEDs with current limiting resistance built in. Bipolar LEDs can be powered by DC without regard to polarity or by AC. The Workstation powers the indicator with a +5 VDC signal from the **System Interface PCB**.

LED arrays like this one are extremely reliable, lasting over 100,000 hours in normal use.

Test Points

None available.

Circuit Breakers and Fuses

None.

Troubleshooting

If the X-Ray On indicator doesn't work, and 5 Volts DC is present at the indicator when the system makes X-rays, replace the indicator. You can replace the LED array assembly inside the lamp or the entire indicator assembly.

Removal and Replacement

To replace the LED array inside the X-Ray On indicator assembly, just remove the lens from the indicator, lift out the old array, and put in a new one. To replace the entire X-Ray On indicator assembly, follow these steps:

1. Turn off Workstation, and remove its AC plug from the AC outlet.
2. Remove **Monitor cover**.
3. Remove mounting screws from monitor bezel and move loosened bezel forward to get access to terminals and lock ring on bottom end of indicator assembly.
4. Remove wires from indicator terminals.
5. Remove lock ring from indicator by twisting it counterclockwise.
6. Lift old indicator from bezel and install new one. Secure lock ring.
7. Connect two wires you removed in step 4. There is no polarity to worry about.
8. Mount bezel to bezel frame and secure mounting screws.
9. Turn on Workstation and check X-Ray On indicator for proper operation.
10. Install Monitor cover.

Section 9 - External Interfaces

This section describes the External Interface PCB and the connectors on the rear panel of the Workstation. It is organized as follows:

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- Circuit Description 9-4
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- Parallel Printer Port 9-7
- ARCNET Connector 9-8
- DICOM 3.0 Interface 9-9
- Switch and Relay Control 9-9

References

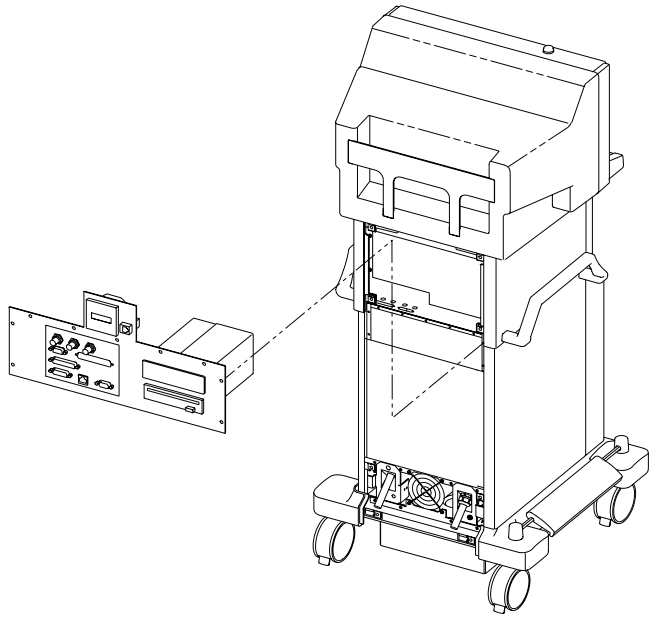
Refer to **Workstation Interconnect Diagram 00-878981** and **External Interface PCB Schematic 00-879184** while reading the following paragraphs.

External Interface PCB

The External Interface PCB provides a way to connect the Workstation to external equipment.

Location

The External Interface PCB is located at the rear of the Workstation as shown next.



External Interface PCB Location

Circuit Description

The primary purpose of the External Interface PCB is to provide a junction point between the Workstation and external equipment such as the ARCNET, Power Injector, **X-Ray On** and **Room in Use** lamps, and switch closure inputs from such devices as a Door Interlock switch. Most of the signals that travel through the PCB do not interface with components on the PCB itself. There are a few exceptions:

- Relay K1 removes the ARCNET termination resistor R1 from the circuit when you connect an external ARCNET device to P4. The Workstation ARCNET circuit has the necessary termination resistance and can be connected to an external ARCNET, laptop, or other ARCNET compatible communications device when there are no node address conflicts on the peripheral devices. K1 is controlled by software from the System Interface PCB.
- Relay K2 provides a software-controllable switch closure to drive an external Power Injector unit.
- Relay K3 provides a software-controllable switch closure to drive and external **X-Ray On** lamp.
- Relay K4 provides a software controllable switch closure to drive an external **Room in Use** lamp.

Test Points

Use TP1 and TP3 to check for +5 VDC across C1 and C4. Use TP2 and TP4 to check for +12 VDC across C2 and C3.

Circuit Breakers and Fuses

There are no circuit breakers or fuses on the External Interface PCB..

Troubleshooting

The External Interface PCB is a simple device consisting mostly of passive components. Its primary function is to conduct signals from various external sources to the appropriate input on the System Interface PCB. There are also four relays on the board. K2, K3 and K4 close switches that may be used to operate external equipment. K1 terminates the ARCNet or connects it to external devices.

When troubleshooting this card, look for a broken connector or physical damage to a trace. The chances of a relay failing shorted are unlikely. The contracts are rated for 2 amps.

Removal and Replacement

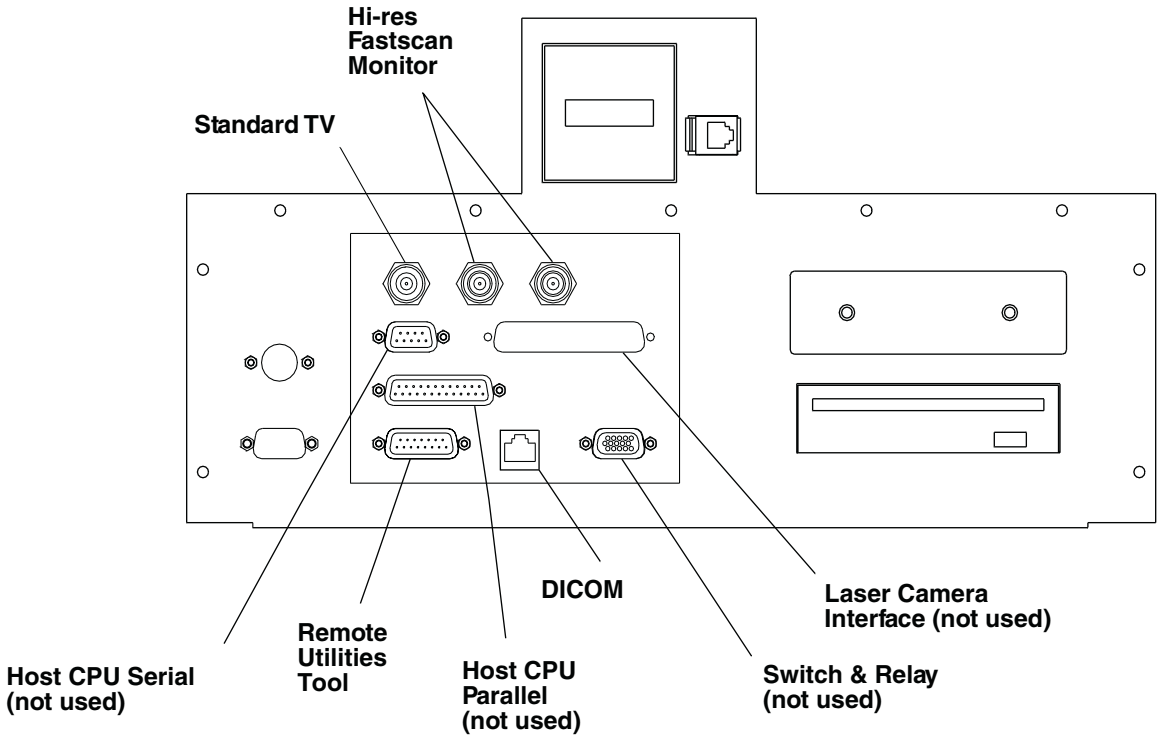
Follow these steps to replace the External Interface PCB:

1. Remove power from Workstation.
2. Remove **Workstation's Rear Cover**.
3. Use Torx screwdriver to remove nine 6-32x3/8 pan head Torx screws that attach External Interface Panel to Electronics Box.
4. Pull out External Interface Panel.
5. Remove cables A3J1, A3J2 and the Ethernet cable that attach to External Interface PCB.
6. Use 3/16" nutdriver to remove the four Jacking screws that hold External Interface PCB to External Interface Panel.

Perform above steps in reverse order to install new External Interface PCB.

External Interface Panel Connectors

The following paragraphs describe individual connectors on the External Interface Panel



External Interface Panel

External RS170/CCIR

This is a BNC connector that you can use for an external video monitor or VCR. Depending on system configuration it supports 60 Hz (RS170) or 50 Hz (PAL) video. The **Display Adapter PCB** (00-881447) provides the video for this connector.

Left/Right High Resolution Monitors

These BNC connectors support additional high-resolution monitors. The **Display Adapter PCB** also provides video to these connectors.

RS-232 Serial Communication

This 9-pin D-type connector is not used.

Laser Camera Interface

This port is not presently used. Laser Camera/Direct Digital Printer output is being accommodated via the Dicom output.

Parallel Printer Port

This 25-pin D-type port is not used.

ARCNET Connector

This 15-pin D-type connector is used by Field Service Engineers to connect a Laptop computer to the Workstation in order to use the Remote Utilities Tool (RUT). The following Table is a detailed pin-out of this connector:

ARCNET Connector

Mnemonic	Pin Number	Description
ARCNET_HI_2	1	One of two differential ARCNET 2 signal lines
ARCNET_LO_2	2	One of two differential ARCNET 2 signal lines
SPARE	3	NC
FRAME_SYNC_HI_2	4	One of two differential Frame Sync 2 signal lines (driven)
FRAME_SYNC_LO_2	5	One of two differential Frame Sync 2 signal lines (driven)
DIAG_TXD	6	Transfer Data (Remote Diagnostics)
DIAG_RXD	7	Receive Data (Remote Diagnostics)
GND	8	Ground
CONFIG0	9	Bi-plane/peripheral configuration bit 0 (Input)
CONFIG1	10	Bi-plane/peripheral configuration bit 1 (Input)
CONFIG2	11	Bi-plane/peripheral configuration bit 2 (Input)
CONFIG3	12	Bi-plane/peripheral configuration bit 3 (Input)
+5V (ARCNET_BIAS_PWR)	13	+5V Supply from Sys. Int. PCB for ARCNET Term. Bus
FRAME_SYNC_LO_SLAVE	14	Frame Sync from other 9800 System for Bi-plane Mode
FRAME_SYNC_HI_SLAVE	15	Frame Sync from other 9800 System for Bi-plane Mode

DICOM 3.0 Interface

The port labeled **Ethernet** connects the Workstation to a facility network, typically for image transmission. All network hardware and software is customer furnished.

Switch and Relay Control

This 15-pin D-type connector provides relay closure outputs for such things as **X-ray ON** and **Room in Use** lights, and Power Injector operation. Relays on the External Interface PCB.

The following is a detailed pin-out of this connector:

Switch and Relay Control

Mnemonic	Pin Number	Description
PWR_INJCT_1	1	Power Inject relay switch contact
XRAY_ON_1	2	X-ray On Lamp relay switch contact
RM_IN_ISE_1	3	Room In Use relay switch contact
DR_INT_SW	4	Door Interlock switch line 1
DR_INT_SW_RTN	5	Door Interlock switch line 2
PWR_INJCT_2	6	Power Inject relay switch contact
XRAY_ON_2	7	X-ray On Lamp relay switch contact
RM_IN_USE_2	8	Room In Use relay switch contact
START_SW	9	Start switch line 1
START_SW_RTN	10	Start switch line 2
SPARE CONDUCTOR	11	No Connect
SPARE CONDUCTOR	12	No Connect
SPARE CONDUCTOR	13	No Connect
SPARE_SW	14	Spare switch line
SPARE_SW_RTN	15	Spare switch line

Section 10 - Software

This section contains information on the Workstation software and System Diagnostics. It is organized as follows:

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Workstation Software Functions

The system operates almost entirely under software control. When you press a button or operate the Touch Screen, you are really writing data to control registers that software reads and acts upon. System software also generates responses to operator commands and generates operator messages. System response to control actuation is near real time; that is, it is not visibly slower than what would occur with hard-wired controls.

Software's response to control actuation depends on the current operational mode, system configuration, and a number of other variables. This results in precise, accurate system control and monitoring, which does much to improve the speed, safety, and accuracy of system operation. The software performs many checks to make sure it is safe to the patient, operator, and equipment before generating X-rays.

System software executes on the Host Pentium motherboard, and while the system is on, it communicates with a number of intelligent system PCBs in the Workstation and in the external equipment over the ARCNet, exchanging commands, status information and data with these PCBs. Configuration information remains in flash RAM during power-down periods. Configuration data can be overwritten by the Remote Utilities Tool and system software.

The more you understand about the software's features and characteristics, the better you'll be able to troubleshoot the system.

Security

System software provides these three security features:

- The system software cannot be accessed or changed by the user.
- The user cannot access any internal disk operating system functions.
- The software performs tests during system initialization that determine if the software is loaded correctly.

Bootup

The following paragraphs describe bootup events for the Workstation. To observe a reasonably complete bootup sequence, you'll need to connect your VGA debug monitor to the VGA port on the rear panel of the Workstation. Other boot sequence events and messages appear on the Workstation monitors. The boot sequence can vary slightly from system to system depending upon configuration.

Time Required

Normal boot-up time for the system is about 80 seconds.

Boot Sequence Example

The Workstation boot sequence depends on system configuration. Event sequence differs according to model and installed options. The following example shows typical boot information you can see on the service monitor as the system boots. The example shows the Left Monitor displays followed by an explanation of each display.

Debug Monitor Boot Screen #1

```
WS_INIT:  ********************************************************
WS_INIT:                    OEC Medical Systems Inc.
WS_INIT:   PN879130-xx - Sep  9 1999 - 13:09:32
WS_INIT:  Copyright (c) 1993-1994 ATI - Nucleus PLUS - 386/486 Nucleus PC 1.5.G1.1+
WS_INIT:   The Current Time is: 9/15/1999 - 16:8:20
WS_INIT:  ********************************************************
```

Explanation:

This block provides the part number of the release PN879130-XX. XX is the dash number, the date the release was built, and the date of the last boot.

Debug Monitor Boot Screen #2

```
WS_INIT:  WORKSTATION INITIALIZATION BEGINS
FFB_NETI: My DiagStat was 30 and Recon Count = 0
GEN_NETI: My DiagStat was 30 and Recon Count = 0
WS_NETI:  My DiagStat was 72 and Recon Count = 1
```

Explanation:

This block shows that the processors on the Fluoro Functions PCB, the X-Ray Controller PCB, and the Systems Interface board booted correctly, and that ArcNet node mapping has occurred. If the Recon Count is high there may be a problem with one of the processors or the ArcNet.

Debug Monitor Boot Screen #3

```
FW_UTIL:  No Download Pending
```

Explanation:

This block shows that the FFB, the X-ray controller and the System Interface processors have had their programs loaded and are ready to initialize. If code needs to be loaded, there will be messages showing what processor is loading and what block in that process is loading.

Debug Monitor Boot Screen #4

```
WS_INIT:  Waiting for Analysis Tasks Ready
WS_INIT:  SubSystem Initialization Started
WS_INIT:  *** 30 FPS SYSTEM ***
```

Explanation:

Shows the Workstation is initializing and that the system is a 30 frame per second CINE system.

Debug Monitor Boot Screen #5

```
WS_TIMR:  WS  Min:  8  Secs: 28  FSyncs: 0       RTC Secs: 28
```

Explanation:

Real Time Clock Setting

Debug Monitor Boot Screen #6

```
WS_TIMR:  Time Sent to GEN
WS_TIMR:  Time Sent to FFB
WS_TIMR:  Time Sent to SRV
```

Explanation:

Indicates that the Workstation, the X-Ray Controller, the Fluoro Functions PCB and the System Interface processors are communicating. Clocks are synchronized on all of the ArcNet nodes.

Debug Monitor Boot Screen #7

```
FW_UTIL:  Checking Version Data
FW_UTIL:  Checking Version Data
FW_UTIL:  Checking Version Data
```

Explanation:

Compares the Workstation software version with the Generator software version. The Workstation and the Generator need to run the same version level.

Debug Monitor Boot Screen #8

```
WS_INIT:  Initializing DCTL
```

Explanation:

Initialization of the Display Adapter Controller

Debug Monitor Boot Screen #9

```
WS_INIT:  Showing OEC Logo
```

Explanation:

The OEC logo should appear on both the left and right monitors shortly after this message appears.

Debug Monitor Boot Screen #10

```
WS_INIT:  Human IF Screens Initializing
```

Explanation:

All the screens and menus that the user will see are becoming ready to use.

Debug Monitor Boot Screen #11

```
WS_INIT: Human IF Control Panel Initializing
```

Explanation:

All the buttons and keyboards that the user will see are becoming ready to use.

Debug Monitor Boot Screen #12

```
FW_UTIL: No Download Pending
```

Explanation:

Same as previous message

Debug Monitor Boot Screen #13

```
WS_INIT:  SIO DOMAIN Initializing
```

Explanation:

The code that controls serial I/O (monitor brightness and contrast) is loading.

Debug Monitor Boot Screen #14

```
WS_INIT:  Video Controller PIO DOMAIN Initializing
```

Explanation:

The code that controls the hardware in the Image Processor, the Video Controller, and the Display Adapter is loading.

Debug Monitor Boot Screen #15

```
DAP_CMP:  Loading dose tables
DAP_CMP:  iris indexes:  0.00 18.57 32.85 47.14 61.42 72.85 81.42 90.00
DAP_CMP:  shutter indexes:  0.00 16.14 28.82 41.12 53.80 63.79 71.09 78.78 86.47 98.00
DAP_CMP:  Dose table loaded
```

Explanation:

The system is loading the Dose Area Product calibration tables.

Debug Monitor Boot Screen #16

```
WS_INIT: DP Initialization Started
```

Explanation:

The controlling software for the Image Processor, the Video Controller, and the Display Adapter is loading.

Debug Monitor Boot Screen #17

```
WS_INIT:  Application Initialization Started
```

Explanation:

The system application software is loaded.

Debug Monitor Boot Screen #18

```
CINCINE:  Cine Initialization Started
```

Explanation:

The Cine Disk subsystem and disks are being initialized.

Debug Monitor Boot Screen #19

```
CINCINE:  Cine Initialization Completed
```

Explanation:

The Cine Disk subsystem initialization is complete.

Debug Monitor Boot Screen #20

```
GEN_CI:  Iris is Calibrated
GEN_CI:  Collimator Min Value Set
GEN_CI:  Collimator Max Value Set
GEN_CI:  Leaf rotation is calibrated
GEN_CI:  Leaf opening is calibrated
GEN_CI:  Camera Rotation is calibrated
```

Explanation:

Collimator calibration data is transferred from the X-Ray Controller Flash memory to Fluoro Functions PCB system memory.

Debug Monitor Boot Screen #21

```
GEN_CI: Waiting for Mag Mode Event for Home Picture
```

Explanation:

Not displayed if RETAIN LAST was selected in the Workstation's Customize menu.

Debug Monitor Boot Screen #22

```
WS_INIT:  DEC21143 20C6 0 32002000
```

Explanation:

Ethernet card initialization is complete.

Debug Monitor Boot Screen #23

```
WS_INIT:  DICOM Init Complete Speed = 14
```

Explanation:

DICOM code initialization is complete. Speed = 14 means 100 BaseT

Debug Monitor Boot Screen #24

```
WS_INIT:  Serial Number 89-0007
```

Explanation:

Provides the system serial number.

Debug Monitor Boot Screen #25

```
WS_INIT:  SubSystem Initialization Complete
```

Explanation:

Bootup is complete.

Debug Monitor Boot Screen #26

```
CAM_DAT:  Camera Cooler Data Sent
```

Explanation:

Camera cooler duty cycle table has been sent from the Workstation to the Fluoro Functions PCB memory.

Workstation Defaults

After normal bootup, the Workstation defaults to the following conditions:

Monitors

- Right-hand monitor displays the **Patient Information Screen**.
- Left-hand monitor displays OEC Medical Systems logo.

Workstation

- Auto Contrast and Brightness are both ON.
- Auto Swap is OFF.
- Auto Save at end of exposure is OFF.
- Auto Playback When Cine Acquired is ON.
- Cine Acquire is OFF in both Fluoro and HLF modes.
- Crop is OFF.
- The date format is MM/DD/YYYY.
- Dose Units are in mRad.
- Edge Enhance is ON.
- Landmark is OFF but enabled.
- Mode is Standard Fluoroscopy.
- Negate is OFF.
- Noise Filtering is ON and set to 8.
- Peak Opacify is OFF.
- Pulse/Continuous is set to Continuous.
- Re-registration is OFF but enabled.
- Zoom is OFF.

Other Initial Conditions

- If your system is equipped with a Cine disk system that fails to initialize during system boot, the following message appears: **CINE DISK FAILURE**.
- If the Touch Screen fails to initialize during system boot, the following message appears: **TOUCH SCREEN FAILURE**. This failure could be caused by a cable being disconnected, or by a serial interface problem.
- If an LED is burned out on the Touch Screen, or if there is something blocking an LED on the screen, the following message appears: **TOUCH SCREEN OBSTRUCTION**.
- If your system is equipped with DICOM and the Workstation cannot establish a network connection with the DICOM server, the following message appears: **CANNOT MAKE NETWORK CONNECTION**.
- If the Keyboard fails to initialize during system boot, the following message appears: **KEYBOARD FAILURE**. This failure could be caused by a cable being disconnected, or by a serial interface problem.
- During system initialization, the software makes a compatibility check between the Workstation and generator by comparing version labels. If the Workstation and generator are incompatible, the following message appears: **WORKSTATION AND GENERATOR ARE NOT COMPATIBLE**.
- If your system is equipped with a Jaz disk drive and that drive fails to initialize correctly, the following message appears: **HIGH CAPACITY DISK FAILURE**.

Workstation Messages

The following is an alphabetized list of messages that may appear on the right-hand Workstation monitor. Some messages appear as a result of start-up failure or failure during operation of the system. Other messages appear during normal operation of the system. Workstation failures may result in impaired system operation or automatic system shutdown. Clear a message from the Workstation monitor by touching the **OK** button on the right-hand monitor.

CANNOT MAKE NETWORK CONNECTION - This message appears when a DICOM-equipped Workstation cannot establish communications with the DICOM server. Solutions: Verify that the Workstation is connected to the network. Check DICOM connection internally and externally. Check DICOM PCB. Ask System Administrator to check DICOM server.

CINE DISK FAILURE - During system boot-up the system issues an initialization command to the Cine disk subsystem. This message appears when the Cine disk subsystem fails to initialize correctly.

CINE PLAYBACK NOT AVAILABLE - When the Jaz disk is the **COPY FROM** source and you select a Cine run mini-image from the **IMAGE DIRECTORY** screen, this message appears on the right monitor.

COPY OR PRINT IN PROGRESS - Please wait.

DICOM SERVER IS OUT OF RESOURCES -- TRY AGAIN LATER - This message appears when the DICOM server is busy. If the message persists, ask the system administrator to check the DICOM server.

DISK FORMAT IS IN PROGRESS - This message appears when the currently selected COPY TO device is being reformatted.

DISK FULL - This message appears during a copy process when the destination disk (or diskette) has insufficient room for the new data. Touch the **CANCEL** button to terminate the copy in progress, or insert another diskette and touch the **OK** button to resume the copy.

FORMATTING ERASES ALL DATA ON THE DISK - You will see this message when you touch the **REFORMAT** button on the **COPY FORMAT** screen. It's just a friendly reminder that the disk formatting you're about to do is serious business that is not reversible.

HIGH CAPACITY DISK FAILURE - This message appears during system bootup when the Jaz disk drive fails to initialize correctly due to incorrect installation or other failure. Solutions: Check cabling. Check configuration. Check SCSI controller PCB.

INVALID YEAR - This message appears when you make an invalid entry in the **CUSTOMIZE DATE/TIME** screen. You must enter a value from 1976 to 2075.

KEYBOARD FAILURE - This message appears during bootup when communications between the Workstation and Workstation keyboard is not established. Solutions: Reboot Workstation, keeping power off for five seconds. Check keyboard cabling. Check Control Panel Processor PCB.

NO DISK IN DRIVE - When you are preparing to copy to a Jaz drive or to a floppy disk, the system checks to see if a disk is actually mounted in the drive. If no disk is present, the system generates this message.

PLEASE WAIT - The system displays this message when it needs more time to complete a print or a copy.

PRINT FORMAT NOT SUPPORTED - The Workstation displays this message when you send a document to the printer in a format that the printer doesn't understand. Solutions: Use the CUSTOMIZE menu to select a compatible format. Contact the network administrator for assistance.

PRINTER ERROR - This message appears when the printer reports a hardware error condition to the system. Solution: Check the printer for a displayed error message, and refer to printer's operating instructions for more information.

PRINTER IS OUT OF FILM OR PAPER - This message appears when the printer notifies the system that it is out of film or paper.

PRINTER NOT RESPONDING - When you send a job to the printer, the system expects a response before printing begins. You'll get this message if the system doesn't get a response from the printer.

PRINTER OFF-LINE - This message from the printer appears when you send data to be printed, but the printer is off line. Place printer on-line and resubmit the print job.

REMOTE CONTROL BATTERY IS LOW - The handheld Workstation remote control continually monitors its battery for adequate charge and reports this information to the Workstation. This message appears on the Workstation monitor when battery charge is too low to reliably operate the remote.

SYRINGE ICON - The syringe icon appears on the Workstation monitor when it is time to inject contrast media.

SYSTEM ERROR DETECTED - This message appears when the system detects an error condition. The usual response is to restart the system to clear the error condition.

THE CINE DISK IS NOT AVAILABLE - This message appears when the Cine Disk is inoperative or incorrectly configured. Solutions: Use RUT to check Cine status. Check cabling. Check Cine drive(s) and Cine power supplies.

THE CINE DISK IS OVERHEATING - Software monitors a thermistor in the Cine Disk subsystem to determine disk temperature. If the thermistor reports back a temperature over 55ºC (± 5%), the system displays this message.

THE CURRENT CINE RUN WILL FILL THE CINE DISK IN APPROXIMATELY 30 SECONDS - Cine acquisition stops when the current run fills the disk(s). This message appears when 30 seconds before that happens.

THE CURRENT SESSION CINE RUNS WILL BE OVERWRITTEN IN 30 SECONDS - If you're doing a cine run and you're half a minute or less from running out of Cine disk space, this message appears. If you continue with Cine acquisition, the system overwrites the oldest Cine Disk files first.

TOUCH SCREEN FAILURE - If the Touch Screen fails to initialize during bootup, this message appears on the Workstation monitor. Reboot the system (leaving power off for at least five seconds) to clear this error. If the error persists, check cabling and power to the Touch Screen hardware.

TOUCH SCREEN OBSTRUCTION - This message appears if the Touch Screen fails during system bootup due to an inoperative LED or phototransistor, or if a physical blockage of the touch screen's infrared beams exists. For example, an object lying on the Workstation keyboard could extend over the Touch Screen bezel and block one or more infrared beams. Reboot the system (leaving power off for at least five seconds) to clear this error. If the error persists, check cabling and power to the Touch Screen hardware, and check Touch Screen hardware for damaged components.

UNKNOWN PRINTER MODEL - If you try to configure the system to use a printer it doesn't support or is not configured to support, you're going to get this message. Use the CUSTOMIZE screen to make sure the system is correctly configured for the installed printer.

VCR COMMUNICATION FAILURE - This message appears when the system can't communicate with the VCR to play back or record images. Reboot the system (leaving power off for at least five seconds) and try again. If message persists, make sure VCR cabling is OK. Make sure VCR is powered up.

WORKSTATION AND GENERATOR ARE NOT COMPATIBLE - This message appears during the boot process if the Workstation software and Generator software are not compatible. You cannot generate X-rays under these conditions, but you can operate the Workstation independently.

WORKSTATION IS OVERHEATING - This information will be supplied in a future version of this manual.

WORKSTATION KEYBOARD ERROR - This message identifies an error in the serial communications between the Workstation and the Workstation Keyboard. Reboot the system (leaving power off for at least five seconds) and try again.

Image Processing

The system performs a number of automatic procedures that enhance and clarify images. The following paragraphs discuss these procedures.

Image Input Filter

Image input filtering consists of CCD Camera Correction and Input Gamma Correction.

System software performs CCD Camera Correction by sampling the CCD on a regular basis and making adjustments to compensate for variations in pixel gain and offset, and for pixels that may be inoperative. These types of imperfections are normal in charge-coupled displays.

CCD camera response to light is more linear than it was with the vidicon camera tube. However, the vidicon response provides an image that is more suited for the human eye. Input Gamma Correction is a software function that alters the video from the CCD camera logarithmically to make it more pleasing to the eye.

Log/Antilog

A subtracted image shows better detail if both the mask image and incoming live images are filtered to a natural logarithmic scale. However, if an image that has been processed with a log function is directly displayed as a Fluoro image, it appears bright and unpleasant to look at. System software automatically performs both the log and antilog filtering to help keep image quality acceptable.

Motion-Actuated Noise Reduction System (MANRS)

This software function reduces motion artifacts (smearing) in an averaged image by adjusting the amount of averaging it applies to input frames in real time. At lower averaging levels, MANRS uses a larger part of the current input frame to create the next processed video frame.

Dose Area Product

System software calculates and accumulates Dose Area Product (DAP) for the current patient and displays this information every half second on the left monitor while X-rays are on. DAP is a measurement of the radiation released from X-ray tube/collimator assembly; it is not a measurement of the radiation dose absorbed by the patient.

Video Level Indicator (VLI)

Video Level Indication; a digital representation of the CCD camera's current video level. The system servos camera gain until VLI reaches an acceptable value.

Management Functions

System software manages several Workstation functions, as described in the following paragraphs.

Store and Read Brightness and Contrast Data Files

Software stores brightness and contrast calibration values for the left and right monitors in nonvolatile memory. The system uses these values at power-up to set proper brightness and contrast values for each monitor.

Manage Workstation Options

System software generates interfaces with most installed Workstation options including:

- DICOM
- Jaz Drive
- Onboard (Codonics) Printer
- Infrared Remote
- Video Cassette Recorder

The system has hardware-only interfaces for the Lenzar camera, Sony 960 Thermal Printer, and Sony 980 Printer. Just press the **EXPOSE** or **Print** key to copy the current image on the left monitor. Use control panel keys on the individual devices to perform other functions.

Manage Service Port

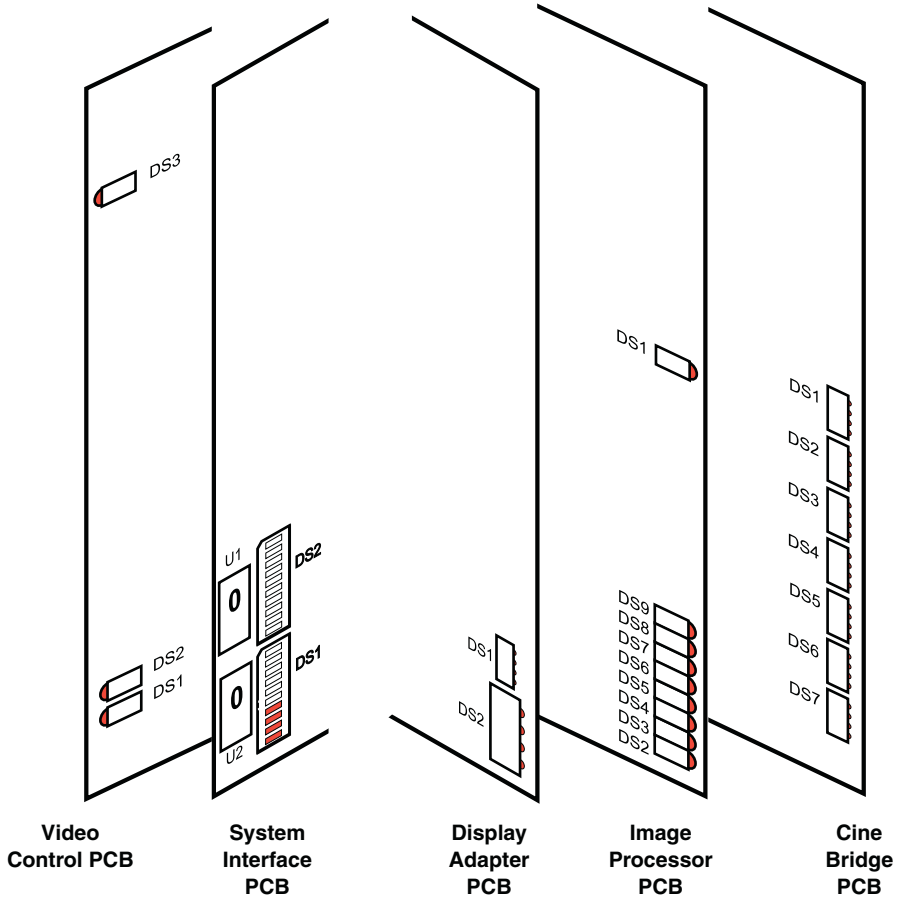
System software manages RS-232 communications between the 15-pin ARCNET connector on the rear panel of the Workstation and the serial port on the laptop computer. Management includes handshaking, security measures, command conventions, etc.

PCB Diagnostic LEDs

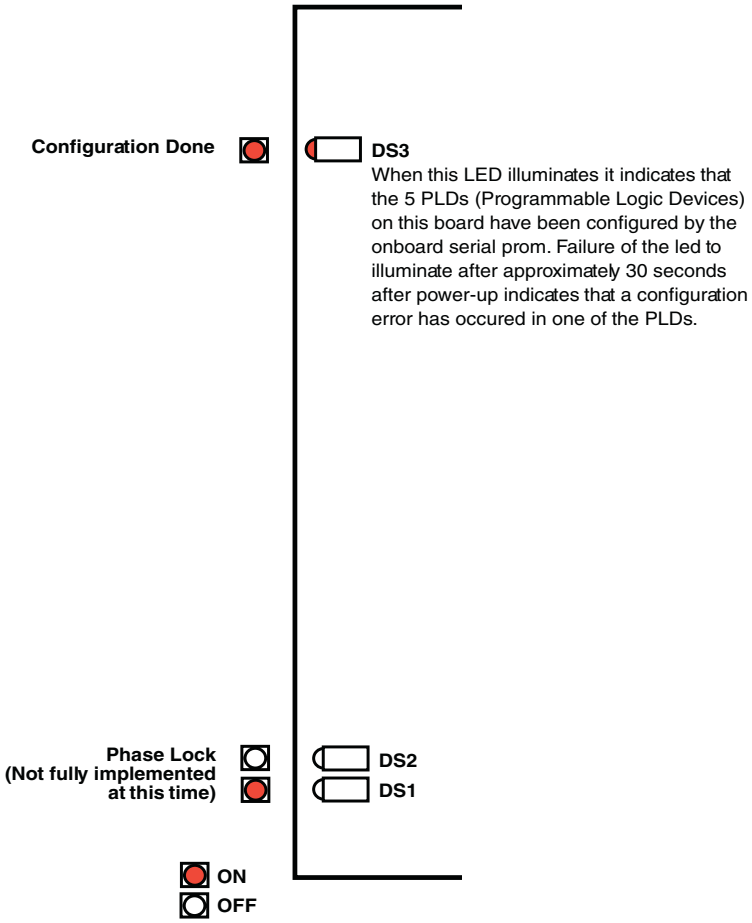
The following illustrations show LEDs on Workstation PCBs that can be used for troubleshooting purposes. All of these PCBs reside in the Workstation, and mate with an ISA or PCI slot on the Host Pentium CPU motherboard as shown in the next figure.

A simplified illustration of the location of these PCBs is shown next, followed by an illustration of the LEDs on each PCB.

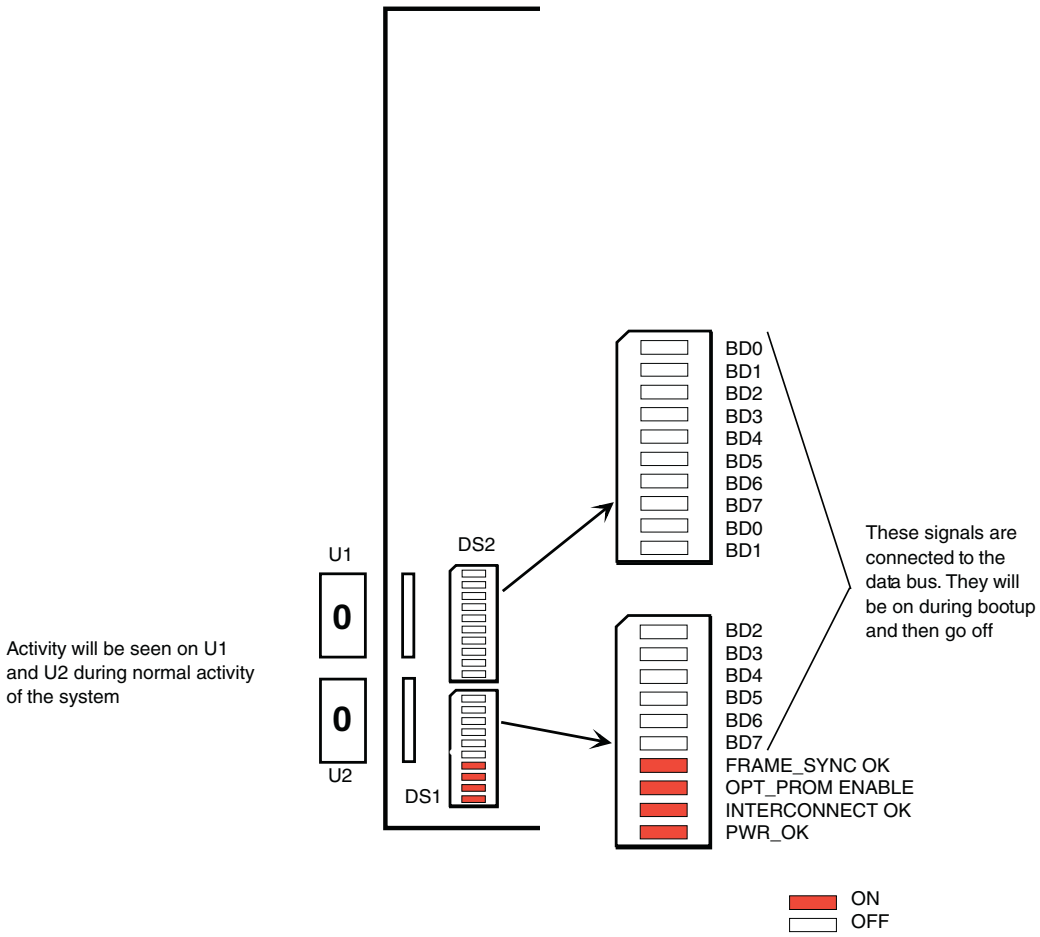
Some of the LEDs don't change state during system operation. Others turn on and off with normal system activity. Other LEDs come on only when the circuit they monitor is faulty.



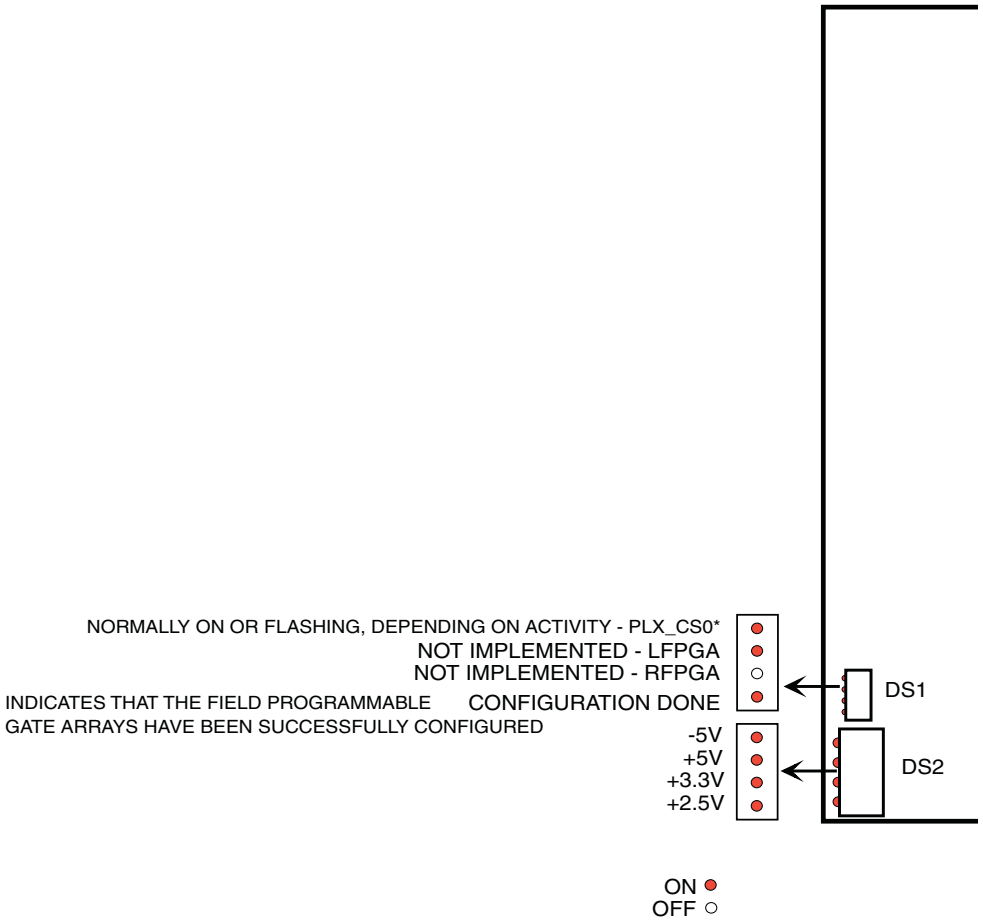
Workstation LED Locations


Configuration Done
DS3
When this LED illuminates it indicates that the 5 PLDs (Programmable Logic Devices) on this board have been configured by the onboard serial prom. Failure of the led to illuminate after approximately 30 seconds after power-up indicates that a configuration error has occured in one of the PLDs.
Phase Lock
(Not fully implemented at this time)
DS2
DS1
ON
OFF

Video Controller LEDs



System Interface LEDs



Display Adapter LEDs

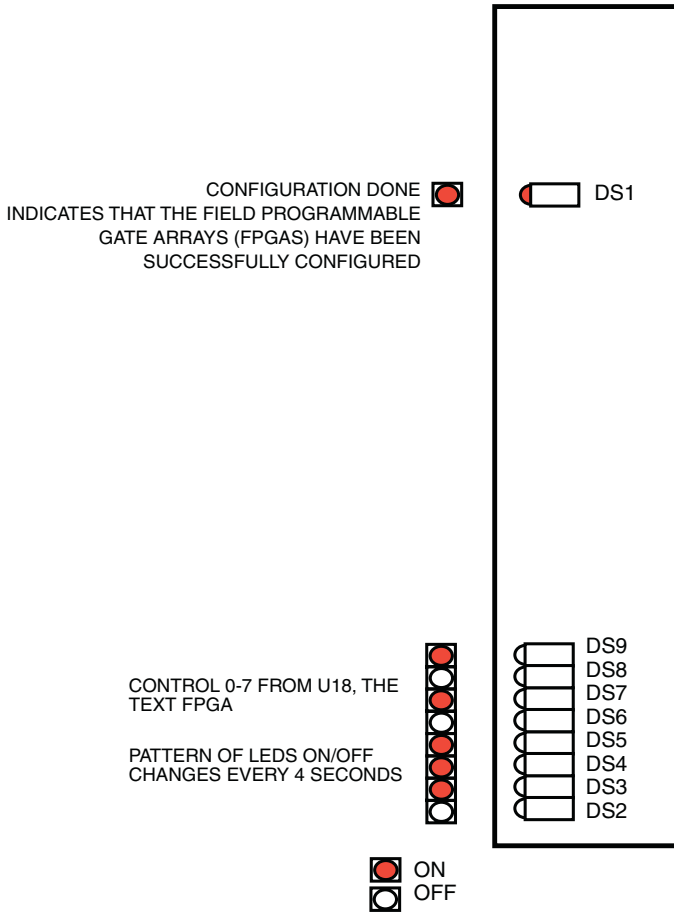
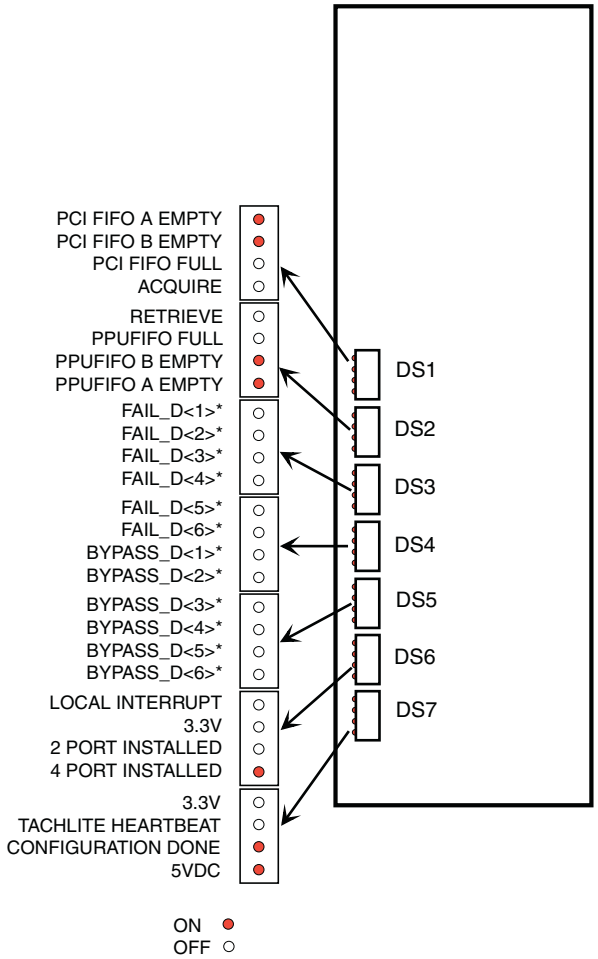


Image Processor LEDs



Cine Bridge LEDs

Section 11 - Mechanical Assemblies

This section describes important mechanical procedures related to the Workstation. It is organized as follows:

Replacement of Instant Film/Paper Printer 11-2
- Remove Old Printer 11-2
- Unpack New Printer 11-9
- Install New Printer 11-11
- Test New Printer 11-13
- Return Old Printer 11-13

Drag Wire Inspection 11-14
Workstation Caster Replacement 11-15
- Caster Details 11-16
- Cable Pushers 11-17
- Brake Pedal 11-18
- Caster Replacement Procedure 11-19

Replacement of Instant Film/Paper Printer

The following paragraphs describe how to replace the Instant Film/Paper (Onboard) Printer in the OEC Workstation.

Remove Old Printer

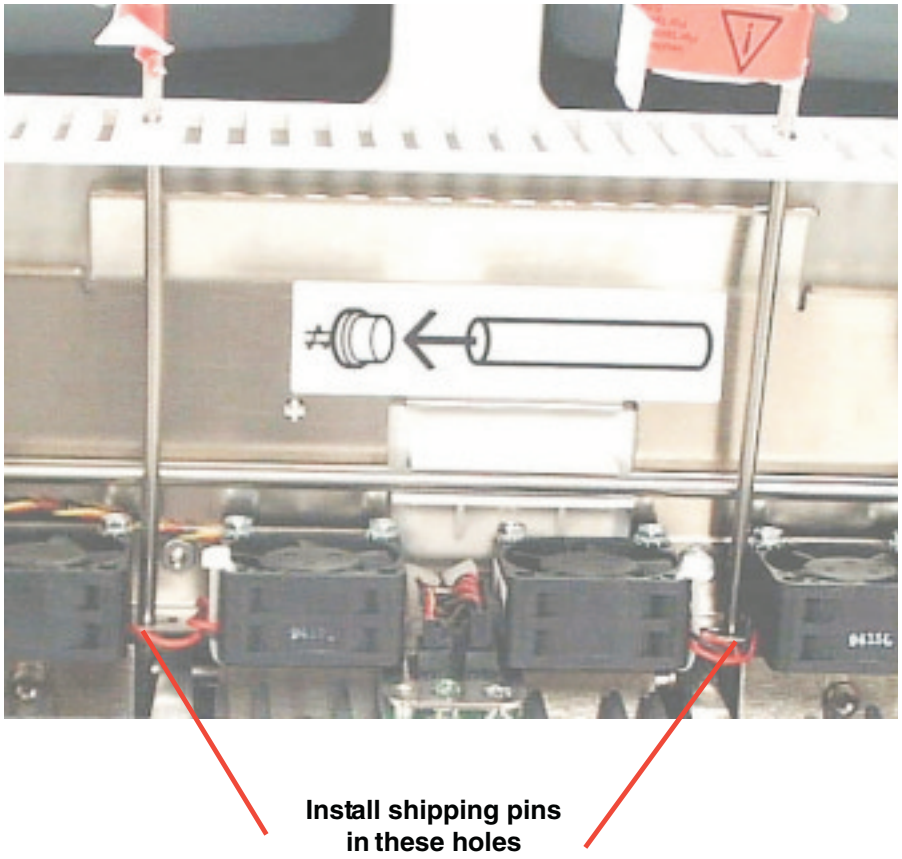
WARNING: *Printer is very heavy. Get assistance when lifting or moving it.*

WARNING: *Be sure to disconnect Workstation from AC line before working on printer. Dangerous electrical shock may otherwise result.*

1. Press Workstation's power pushbutton to turn Workstation OFF.
2. Disconnect Workstation's AC power plug from wall outlet.

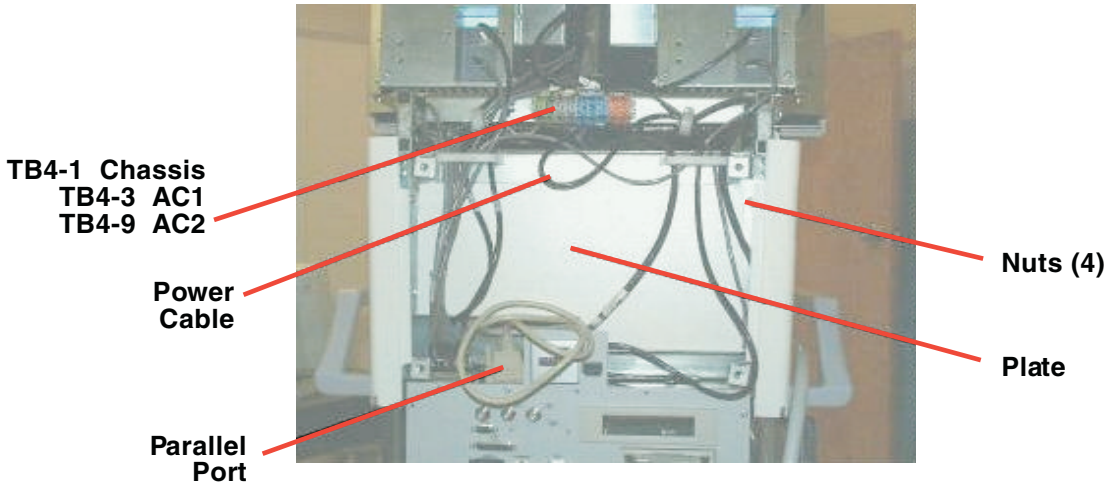
Note: *Shipping pins prevent printhead from impacting platen during shipment. Install them whenever you move or ship printer.*

3. If they are available, install two shipping pins into printer. Make sure each shipping pin aligns with its guide hole before pushing pin into place. Push each pin in firmly until it locks.



How to Install Shipping Pins

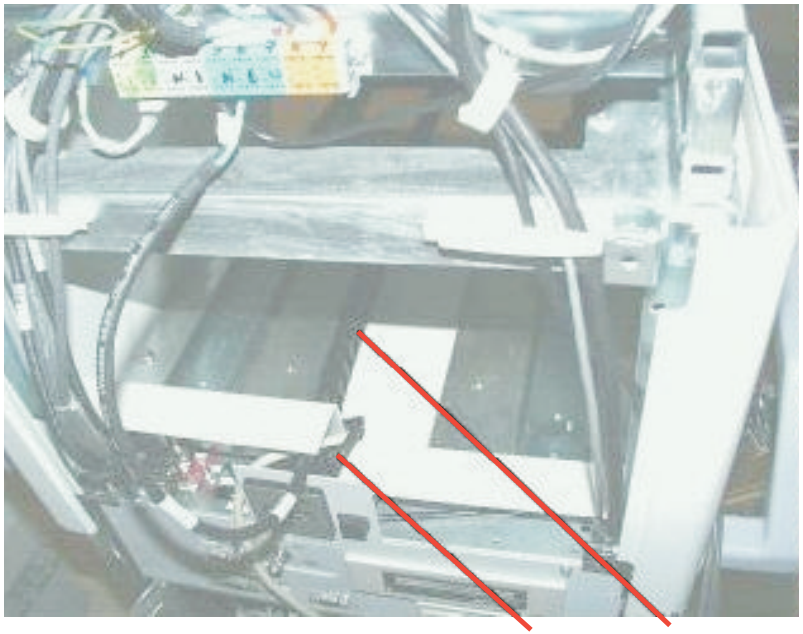
4. Loosen eight quarter-turn fasteners that secure **rear Workstation cover** to Workstation. Remove rear cover.
5. Disconnect printer's 37-pin D-type parallel connector from J3 at rear of Workstation.
6. Disconnect three printer power cord wires from terminal block TB4 located below Workstation monitors: TB4-1 (CHASSIS - GRN/YEL), TB4-3 (AC1 - BLU), and TB4-9 (AC2 - BRN).



Workstation with Rear Cover Removed

7. Remove media tray from printer.

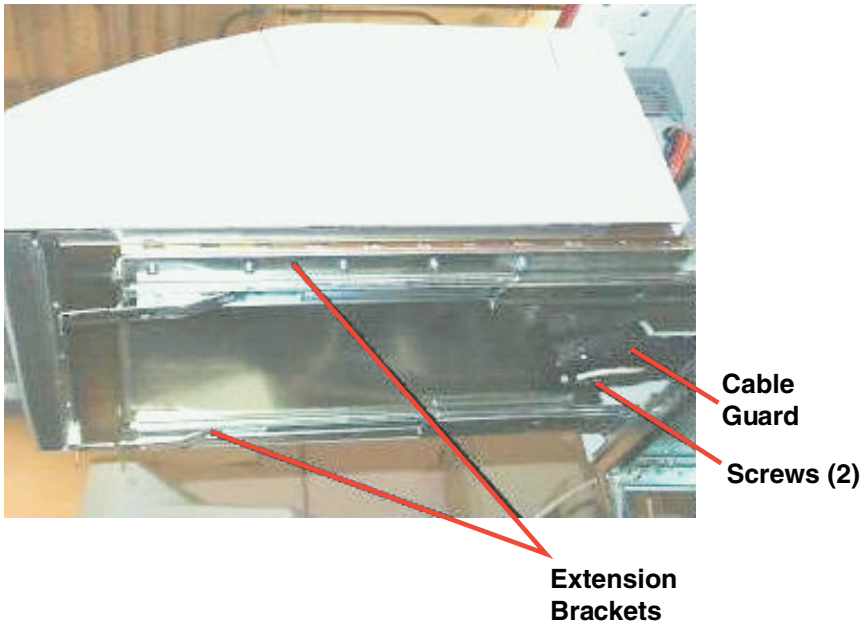
8. Lift up on printer's extension bracket release levers and withdraw printer from Workstation cabinet until extension brackets reach their mechanical stops.



Cable Guard and Extension Bracket Details

9. To gain access to back of printer, remove four nuts that secure metal plate to rear of Workstation. Free metal plate from Workstation cabinet by pushing it toward printer. Turn loosened plate sideways and carefully pull it out opening at rear of Workstation.

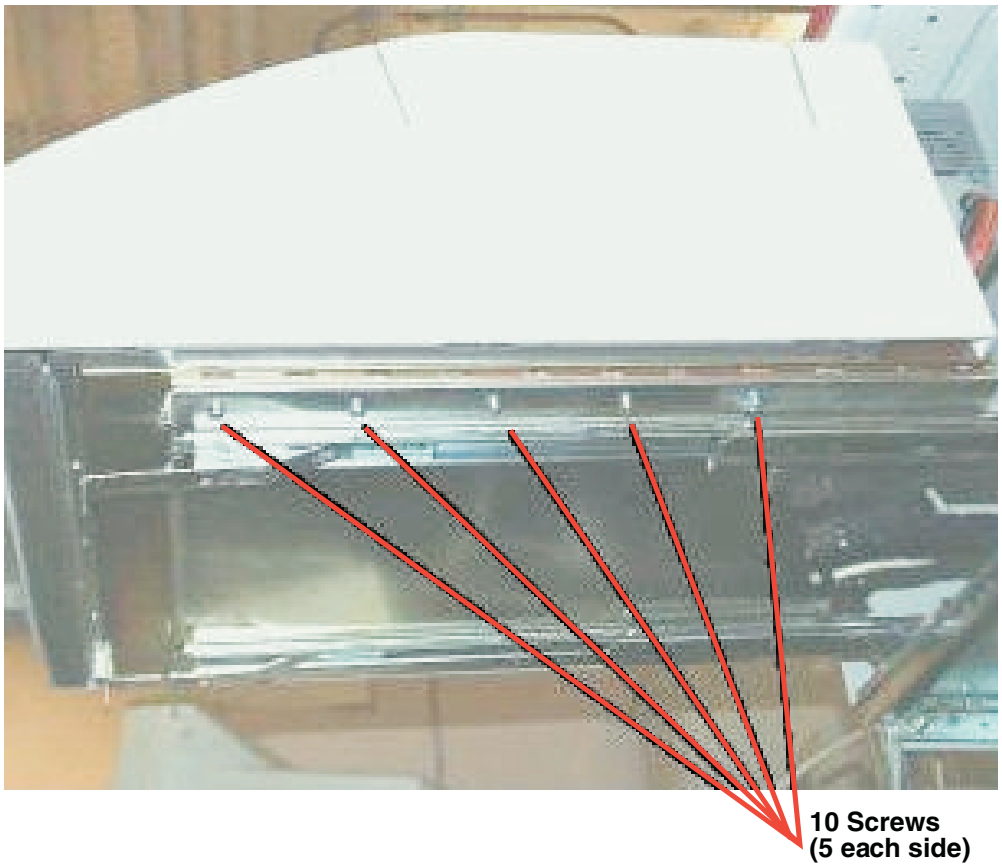
10. Remove two screws and two washers that secure cable guard mounting bracket to rear of Workstation cabinet. Leave bracket attached to cable guard. Retain screws and washers for reuse.



Cable Guard Mounting Details

11. Remove two screws that secure cable guard to extension mounting plate underneath printer. Torx bit in ratchet gives best access to screws. Retain screws for reuse.

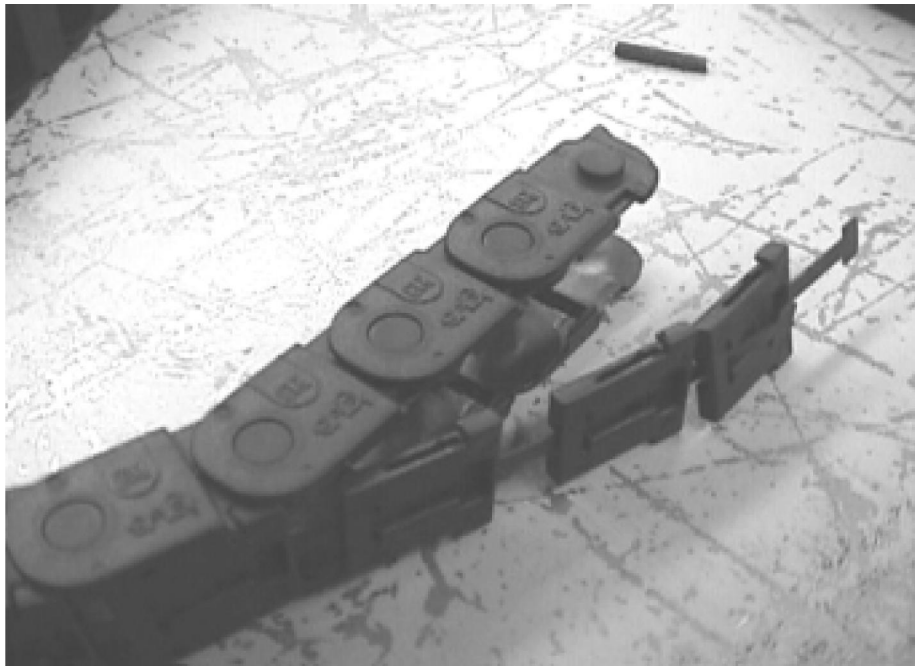
12. Remove ten screws that secure printer to extension mounting plate. There are five screws on each side of printer.



Printer Mounting Screws

13. Remove printer and cable guard from Workstation.

14. Peel side of cable guard off. Remove end link from each end of guard, and retain for reuse. Remove old power cable and old parallel port cable from disassembled cable guard.



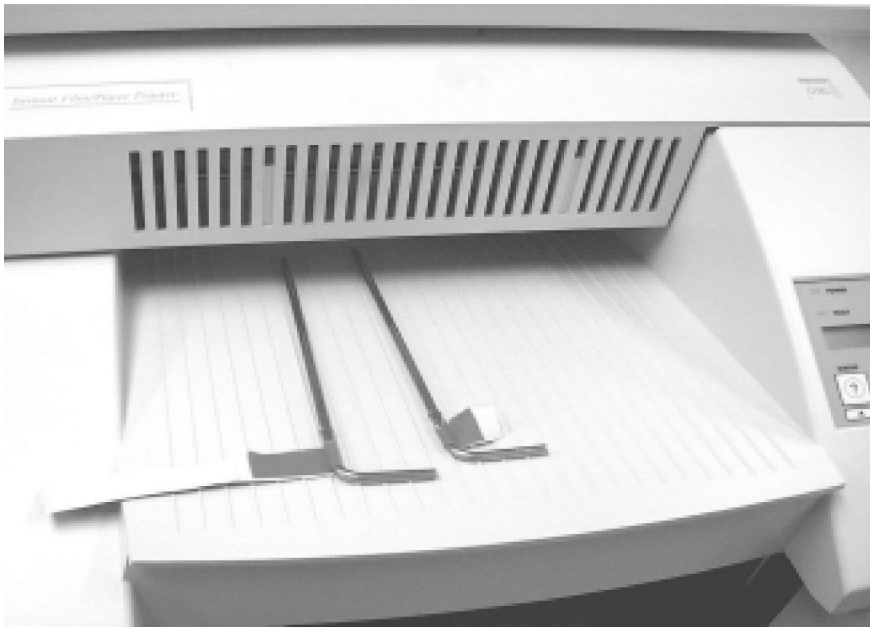
Cable Guard With End Link Removed

***WARNING**: Do not set the printer on its power supply, which is located on the back panel. Damage to the power supply may otherwise occur.*

Unpack New Printer

***Note**: Pay attention to orientation of new printer in shipping box so you can properly pack old printer for shipment.*

1. Remove new printer and shipping base from shipping box. Save all packing material so you can use it to ship old printer.
2. Remove screws that secure printer to shipping base. Save screws and shipping base for reuse.
3. Remove shipping pins from new printer.



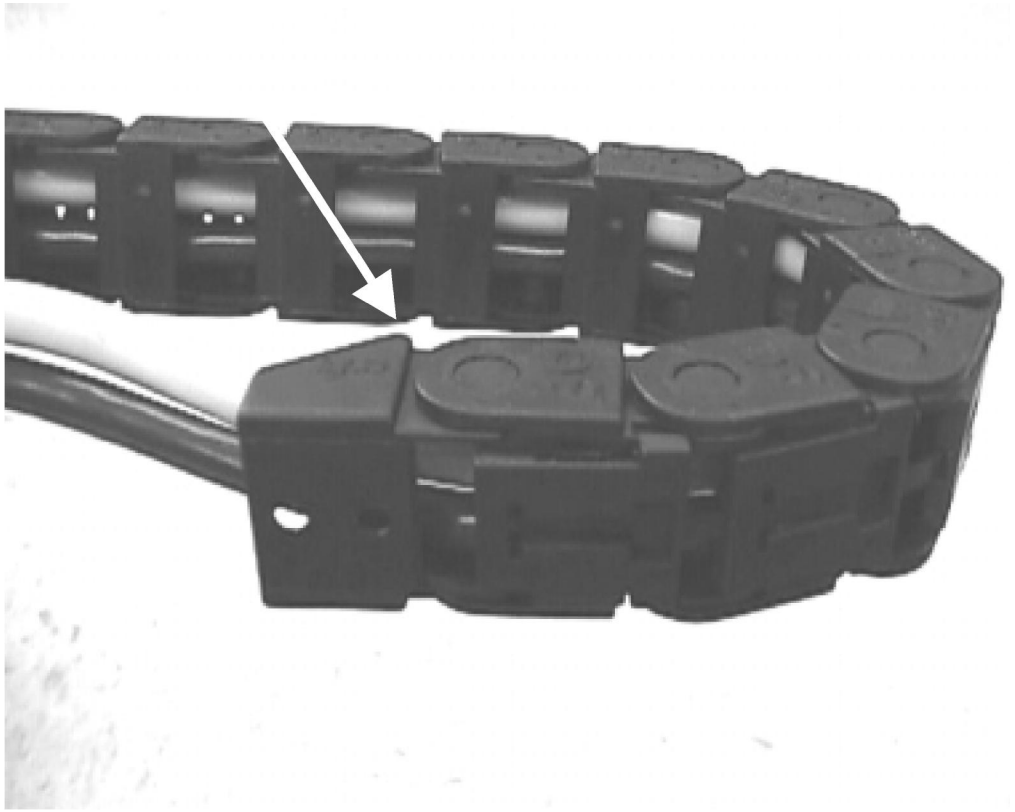
Shipping Pins Removed From New Printer

4. If necessary, insert shipping pins you removed from new printer into old printer to secure printhead and prevent damage during transport. Make sure shipping pins align and seat properly as described on page 2.

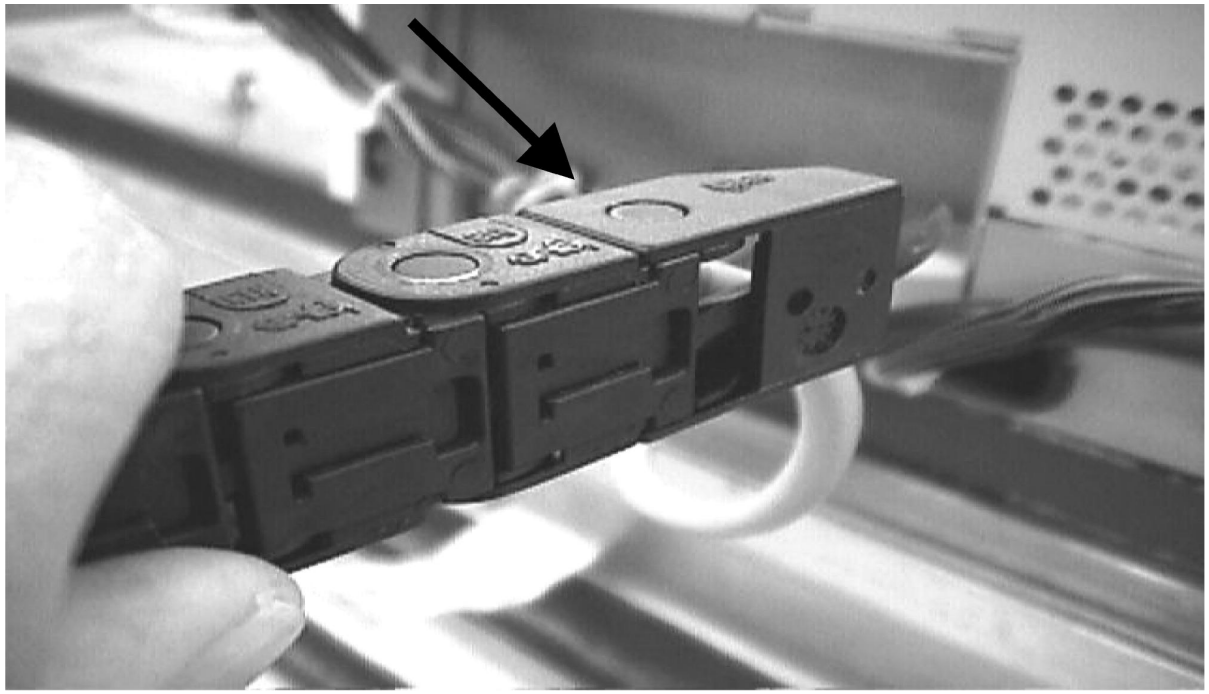
Shipping Pins Installed in Old Printer

Install New Printer

1. Place new printer's power cable and parallel port cable into cable guard and snap cable guard back together.
2. Attach end links to cable guard as shown next.



Cable Guard End That Attaches Under Printer



Cable Guard End That Attaches at Rear of Workstation Cabinet

3. If necessary, reinstall bracket on end of cable guard that attaches at rear of Workstation cabinet.
4. Lift new printer onto extension bracket mounting plate and secure it by installing five screws on each side of the printer (10 screws total).
5. Use two torx screws to connect cable guard underneath the printer.
6. Use two torx screws and two washers to connect cable guard bracket at rear of the Workstation cabinet (figure 4).
7. Connect three wires in printer's power cable to TB4: TB4-1 (CHASSIS - GRN/YEL), TB4-3 (AC1 - BLU), and TB4-9 (AC2 - BRN).

8. Connect printer's 37-pin D-type parallel cable to Workstation's parallel port (J3).
9. Reinstall plate at rear of Workstation cabinet. Insert it sideways into the cabinet and then pull it back into place. Carefully route cabling into position around the plate and install the four nuts you removed earlier.

CAUTION: To avoid damage to print media surface, handle it only by the edges when you load it into the cassette tray.

10. Load media into printer's cassette tray and insert tray into printer. Refer to Operator's copy of Instant Film/Paper Printer supplement for instructions if necessary.
11. Verify that printer's ON/OFF switch is ON, and then slowly push printer into Workstation cabinet. Push printer until you feel it latch in place.

Test New Printer

1. Plug Workstation power cord into an active AC receptacle and press Workstation's power pushbutton. Pushbutton lights when power enters the Workstation.
2. After system boots completely, use Image Directory screen to select an image. Follow instructions in Operator's copy of Instant Film/Paper Printer supplement to print an image.
3. When image prints, reinstall Workstation's rear cover and notify appropriate personnel that printer has been replaced.

Return Old Printer

1. Attach shipping base to old printer.
2. Repackage old printer, using care to orient printer properly in shipping container. Reuse plastic container bag and don't ship with media tray installed in printer.
3. If necessary, contact Logistics for disposition instructions.

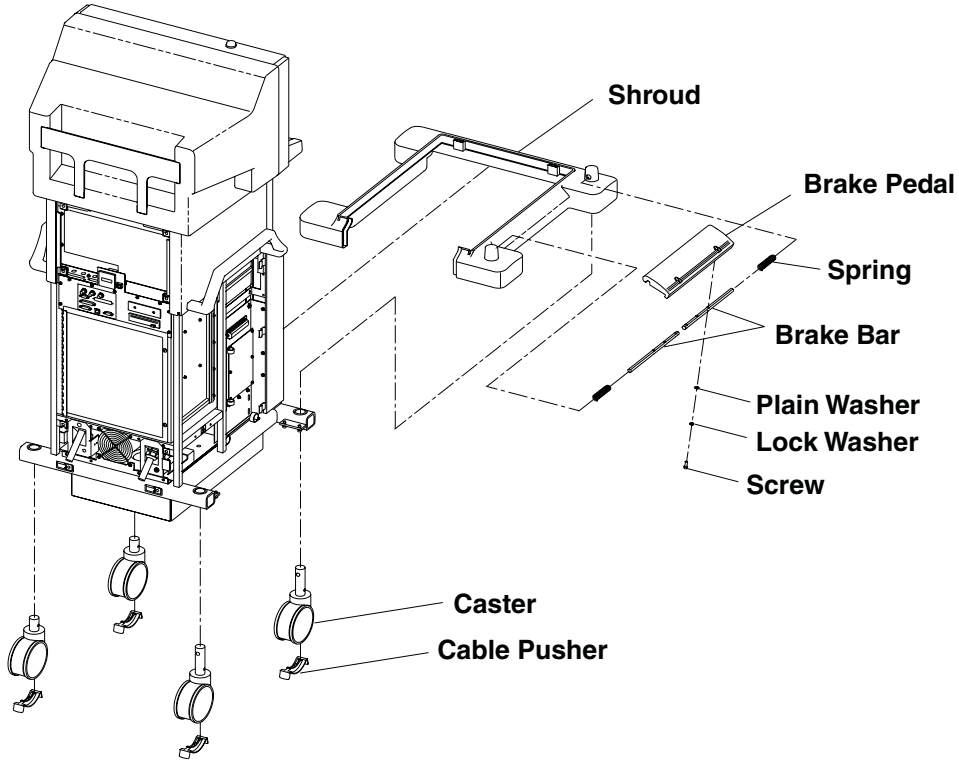
Drag Wire Inspection

A drag wire helps protect Workstation components from electrostatic discharge (ESD) damage. Every time you service or inspect the Workstation, check the drag wire to be sure it is intact, securely mounted, and is not covered with debris. A properly installed and maintained drag wire appears in the following illustration.

Workstation Drag Wire

Workstation Caster Replacement

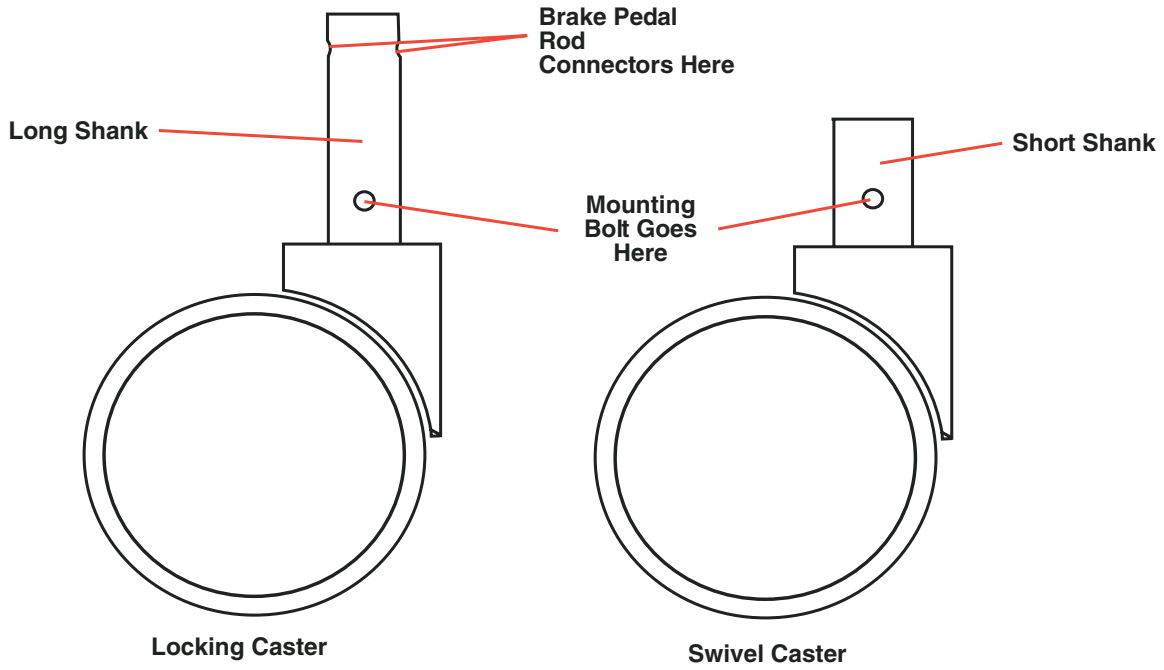
Four pivoting casters support the Workstation, and make it easy and safe for you to roll it across any level surface. Each caster assembly consists of a Locking Caster or a Swivel Caster, and a Cable Pusher. Two casters are controlled by a Brake Pedal, which is described below. The following illustration is an exploded view that shows the casters and Brake Pedal assembly.



Workstation Casters and Brake Pedal

Caster Details

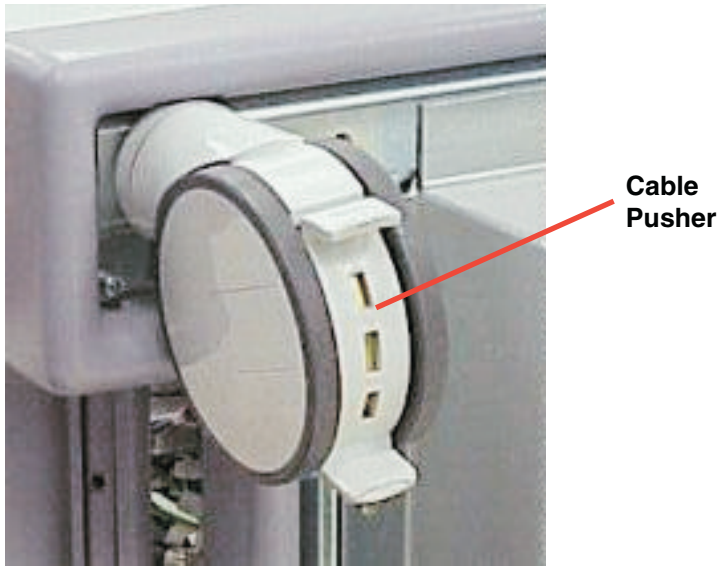
The casters on either side of the Brake Pedal are Locking Casters (OEC Part Number 900696-01) that can be identified by the longer shank. This type of caster contains both a braking mechanism and a pivot lock. The casters on the opposite side of the Workstation are basic Swivel Casters (OEC Part Number 900695-01) that don't brake or have a pivot lock, and have a shorter shank. Both caster types appear in the following illustration.



Workstation Casters

Cable Pushers

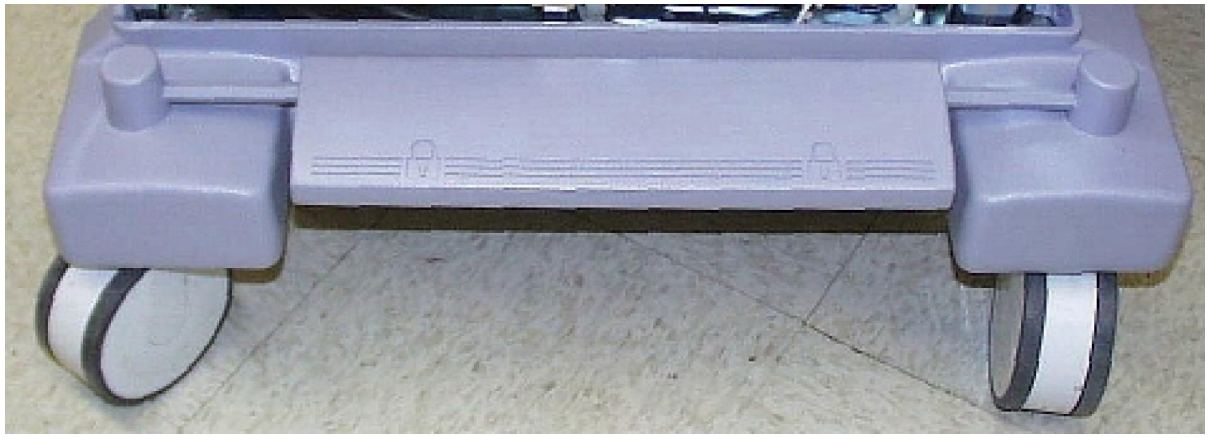
Each Workstation caster is equipped with a Cable Pusher that prevents the Workstation from running over the **Interconnect Cable**, AC power cord, or similar electrical wires. The Cable Pusher clamps onto the caster assembly. You can pry off a broken Cable Pusher by hand or with a flat-tipped screwdriver, and install a new Cable Pusher by simply snapping it in place. A cable pusher appears in the following illustration.



Cable Pusher

Brake Pedal

The brake pedal does more than just stop the Workstation. It is also a steering assist mechanism that locks the pivot on one front caster and one rear caster, pointing them straight ahead so you can roll the Workstation easily down a hallway much like you would a new grocery store cart.



Brake Pedal

Before rolling the Workstation a long distance, lift the Brake Pedal up as far as it will go, orient the Brake Pedal side of the Workstation toward you, and begin pushing the Workstation forward. As the Workstation rolls, the casters nearest you lock into place facing straight ahead, making it much easier to roll the Workstation in a straight line. The casters on the opposite side of the Workstation continue to pivot freely so you can steer the Workstation around obstacles and corners. When you reach your destination, push the brake pedal to the center position so that all four casters pivot freely. After you position the Workstation where you want it, push the brake pedal all the way down to apply the brakes and prevent the Workstation from moving further.

Caster Replacement Procedure

If the Workstation does not move smoothly or easily over a level, hard floor, look for problems with one or more casters. Most often the problem will be debris. If you find a broken caster, replace it as follows:

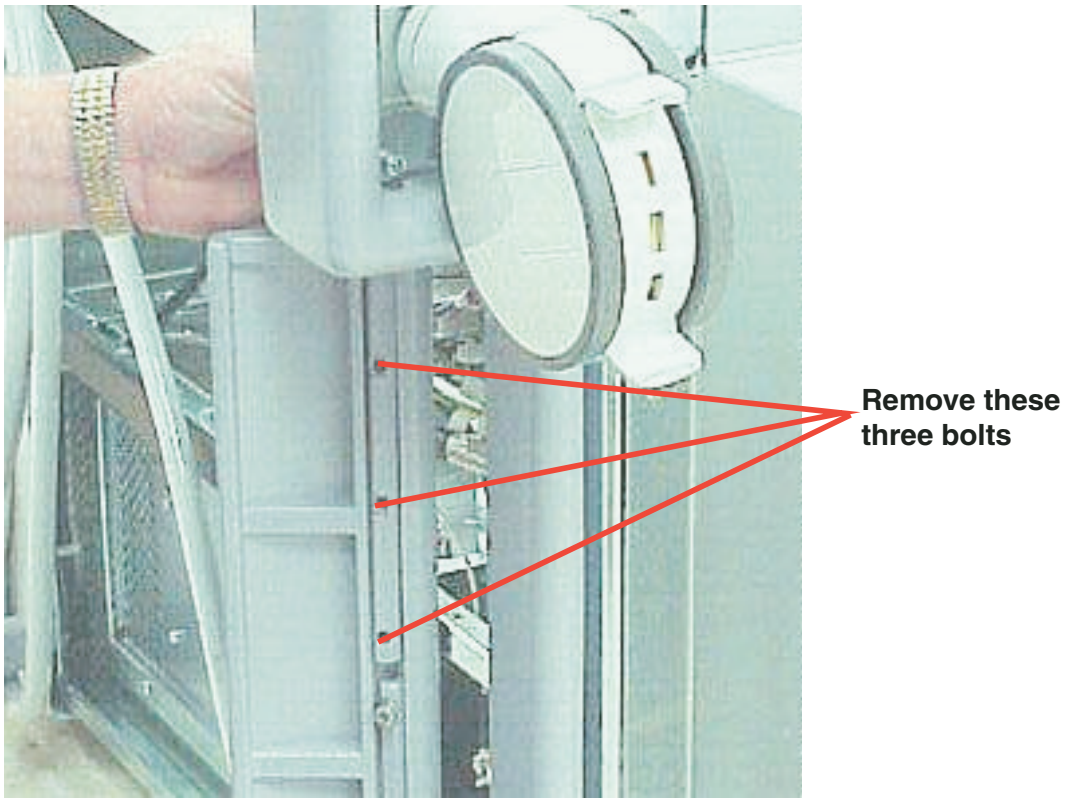
1. Place Workstation power switch in OFF position and disconnect AC plug from wall outlet.
2. Remove all Workstation covers except Monitor Cover.
3. Remove or secure everything that sits on Workstation shelf.

***WARNING**: Workstation is very heavy. Get another person to help you with next step.*

4. Gently tip Workstation over so rear of Workstation rests on floor.

Gaining Access to Casters

5. Remove the three bolts that secure the Brake Pedal to the upper Brake Bar. Be careful not to lose the lockwasher and plain washer on the bolt. This loosens upper Brake Bar so that you can push it down further into the pedal and remove the pedal from the Workstation. Be sure to catch the spring, which will fall when you loosen the upper Brake Bar. Remove the Brake Pedal, both Brake bars, and both springs from the Workstation.

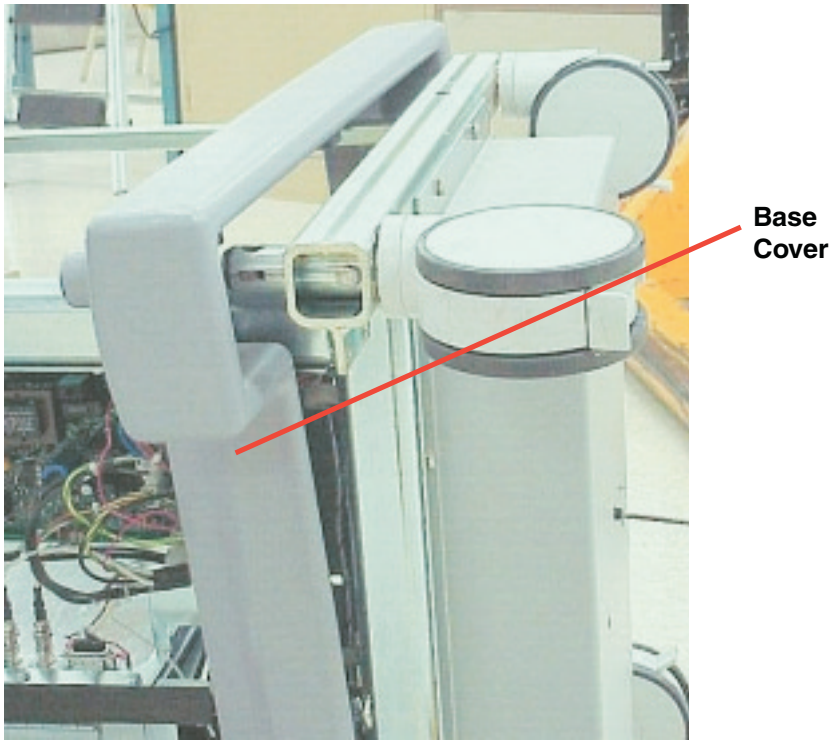


Brake Pedal Removal

6. Loosen and remove mounting hardware that secures Base Cover to Workstation chassis. There are hex nuts located in all corners.

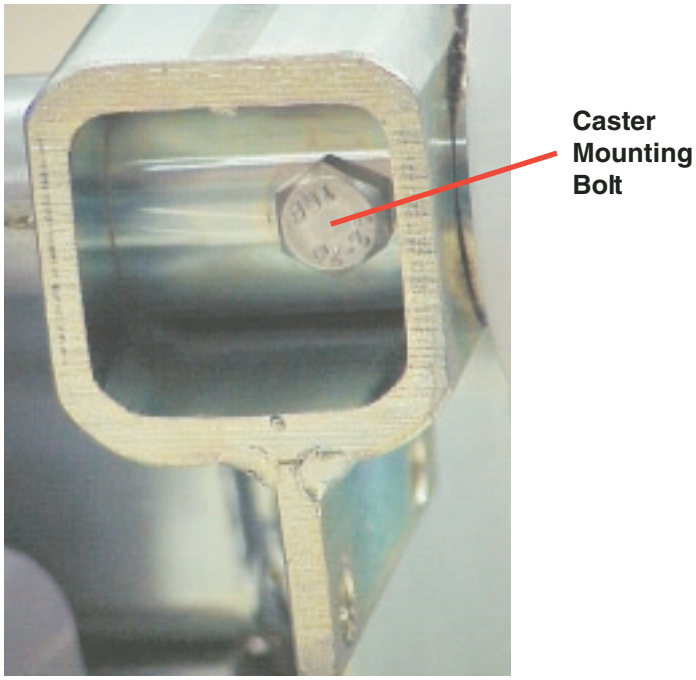
***WARNING**: Workstation is very heavy. Get another person to help you with next step.*

7. Lift Workstation up slightly and slide Base Cover away from casters.



Base Cover Removal

8. Loosen bolt that secures damaged caster to Workstation chassis. Remove bolt and damaged caster.



Caster Mounting Bolt

9. Carefully pry Cable Pusher from damaged caster.
10. Install Cable Pusher on replacement caster.
11. Install replacement caster in Workstation chassis.
12. Clean threads on bolt you removed in step 8. Apply several drops of Locktite 242 to cleaned threads.

13. Install bolt in replacement caster and secure bolt. Ensure replacement caster mounts firmly to Workstation chassis.

***WARNING**: Workstation is very heavy. Get another person to help you with next step.*

14. Lift Workstation up slightly and slide Base Cover back over casters.
15. Install hardware you removed in step 6.
16. Install Brake Pedal you removed in step 5.

***WARNING**: Workstation is very heavy. Get another person to help you with next step.*

17. Set Workstation upright and test new caster for proper operation. Make sure new caster pivots, brakes, and locks like it should.
18. Reinstall any equipment you removed from Workstation shelf.
19. Install all Workstation covers you removed in step 2 and place Workstation back into operation.